TSA Market Development and Innovation

TyreStewardship AUSTRALIA

Tyre derived Crumb Rubber in road surfacing applications in Australia

Market overview

Australian Government Accredited Product Stewardship Scheme

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Market Overview

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Client

Tyre Stewardship Australia (TSA)

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Contents

Acronyms

Acronym	Description
AB	Asphalt Bitumen
BCRA	Bitumen Crumb Rubber Asphalt
C170	Class 170 Bitumen
C320	Class 320 Bitumen
C450	Class 450 Bitumen
C600	Class 600 Bitumen
CR	Crumb Rubber
CRMA	Crumb Rubber Modified Asphalt
CRMB	Crumb Rubber Modified Bitumen
DGA	Dense Graded Asphalt
DIT	Department for Infrastructure and Transport, South Australia
DOT	Department of Transport Victoria
DTMR	Department of Transport and Main Roads, QLD
EOLTs	End of Life Tyres
EME	Enrobe A Module Eleve : High Modulus Asphalt
EPU	Equivalent Passenger Unit
GGA	Gap Graded Asphalt
HSS	High Stress Seal
LGA	Local Government Association
MRWA	Main Roads Western Australia
NACOE	National Asset Centre of Excellence
OGA	Open Graded Asphalt
PBD	Polybutadiene
PMB	Polymer Modified bitumen
SAM	Strain Alleviating Membrane
SAMI	Strain Alleviating Membrane Interlayer
SBS	Styrene Butadiene Styrene
SMA	Stone Mastic Asphalt
SRA	State Road Authority
SSB	Sprayed Sealing Bitumen
SSROCS	Southern Sydney Regional Organisation of Councils
TBC	Total Bitumen Consumption
TDP	Tyre Derived Product
TfNSW	Transport for New South Wales
TfV	Transport for Victoria
TSA	Tyre Stewardship Australia
WARRIP	West Australian Road Research Innovation Program
XSS	Extreme Stress Seal

Glossary

Biogenic
Anything produced by or made of living organisms.

Crumb
A refined rubber product, typically less than 1 mm in diameter, made from recycled tyres.

Disposal
The dumping, landfilling, direct incineration, unsustainable burning, and stockpiling as an end point of used tyres.

Dense/Open/Gap graded asphalt
Asphalt grades with variations in make-up, such as air voids, aggregate size and density, to suit different road requirements.

End-market
The end destination for a product, in this case a tyre-derived product

End-of-life tyre
A tyre that is deemed no longer capable of performing the function for which it was originally made.

End-user
A person or organisation that uses or consumes a product or service, in this case purchasing and using tyre derived products.

Energy recovery
The use of used tyres in a thermal process to recover energy for heat generation or industrial processes.

Environmental Impact Categories
An impact category groups different emissions into one effect on the environment. By converting those emissions into one unit, this translates into one impact category.

Environmental Product Declaration
A standardised and verified document that provides transparent and scientifically sound information about the environmental performance of a product or system over its entire life cycle.

Fossil-based/Fossil-derived
Materials formed from hydrocarbon compounds created from the remains of plant and animal life in Earth's geological past.

Granule
A refined rubber product, typically 2 mm – 15 mm, made from recycled tyres.

In-use
Tyres that are being used for the purpose for which they were originally made.

Life cycle assessment
A methodology for quantifying the environmental impacts of a product or service over the course of its entire life.

Recovery
Used tyres that are collected and either reused, recycled or repurposed either in Australia, or overseas.

Shred
A processed rubber product, less than 150 mm (typically 50-80 mm), made from recycled tyres.

Tyre-derived fuel
A fuel derived from end-of-life tyres and includes whole and shredded tyres used for this purpose.

Tyre-derived product (also Tyre-derived material)
Any product produced from rubber, steel, textile or other material recovered from recycling end-of-life tyre.

Tyre recycler
A business that conducts tyre processing, recovering rubber, steel, textile and/or other materials and processing it into a form whereby it can be used as an intermediate product in the manufacture of a product, or to recover as energy.

Tyre Stewardship Australia
The entity created to administer The Tyre Product Stewardship Scheme.

Tyre collector
An individual or business that collects and/or transports used tyres in any part of Australia. This includes transporters, balers, local waste facility, auto parts recyclers.

Executive Summary

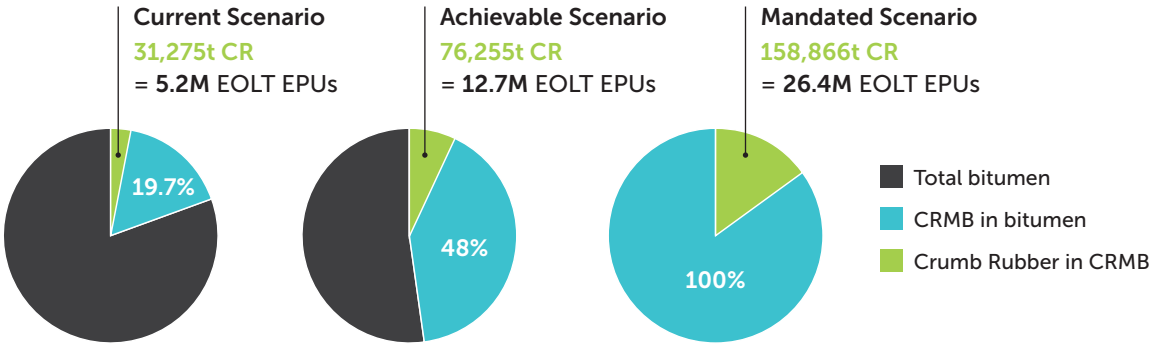
This report provides an overview of the crumb rubber modified bitumen (CRMB) market in Australia. It estimates the demand of CRMB as a percentage of the overall bitumen market from the calendar year 2023 and projects the future demand up to 2026. It estimates the quantities of crumb rubber usage and the end-of-life passenger units (EPUs) consumed under three different scenarios. The three scenarios being, current usage and growth, achievable usage as a result of increased use in low level modified binders for sprayed sealing and emerging asphalt applications and, potential usage under a mandated approach.

The purpose for the report is for Tyre Stewardship Australia to understand the status of the Australian market by State for crumb rubber in road surfacing applications against the overall bitumen consumed and, to estimate the growth potential of the crumb rubber market in the road sector.

On a national basis, the report indicates the current usage (2023) of crumb rubber in road surfacing applications of 24,911 tonnes equating to treating 4,151,875 end-of-life EPUs.

- Under the **current scenario** of predicted growth path, the usage is anticipated to increase to 31,275 tonnes of crumb rubber equating to treating 5,212,500 end-of-life EPUs by the end of 2026.
- Under the **achievable scenario** of increased uptake in crumb rubber in asphalt applications and in a potential widespread use of low levels (5%) of crumb rubber in sprayed sealing, the usage is anticipated to increase to 76,255 tonnes of crumb rubber equating to treating 12,709,248 end-of-life EPUs by the end of 2026. **For this to happen, at least 70% of the bitumen used in the sprayed sealing needs to be modified and 30% of the bitumen used in asphalt needs to be modified.** In sealing applications this would mean increased uptake in 5%, 10% and 15% blends and in asphalt applications this would mean maximum use in Open Graded Asphalt (OGA) and Gap Graded Asphalt using 18% blends. With partial mandate such as the one for OGA by Main Roads WA, calling tenders with specific requirement to use crumb rubber and providing incentives to contractors for using crumb rubber, these targets may be achievable.
- Under a **mandated scenario** requiring the use of 15% crumb rubber in all the bitumen consumed in both the sprayed sealing and asphalt applications. Under the mandated scenario the usage is anticipated to increase to 158,866 tonnes of crumb rubber equating to treating 26,477,600 end-of-life EPUs by the end of 2026. This roughly represents 40% of end-of-life tyres generated.

Below: CRMB and Crumb Rubber usage based on 2026 Projected Estimates for Australia



The report covers a detail state by state analysis with easy-to-understand charts for each of the scenarios analysed. It is recommended to focus on the strategies to promote the use of crumb rubber in areas addressed under the Achievable Scenarios.

Introduction 1

Scope 1.1

This report provides an overview of the crumb rubber modified bitumen (CRMB) market in Australia. It estimates the demand of CRMB as a percentage of the overall bitumen market from the calendar year 2023 and projects the future demand up to 2026. It estimates the quantities of crumb rubber usage and as a result the equivalent end of life passenger units (EPUs) consumed under three scenarios. The three scenarios being, estimate on current usage and growth, achievable usage as a result of increased use in low level modified binders for sprayed sealing and emerging asphalt applications and, potential usage under a mandated approach.

Purpose 1.2

The purpose for the report is for Tyre Stewardship Australia to:

- **Understand the status of the Australian market by each state for crumb rubber in road surfacing applications against the overall bitumen market [Current Scenario]**
- **Estimate the growth of the crumb rubber market in road surfacing applications and the potential that exists with increasing uptake of crumb rubber in sprayed sealing and asphalt applications [Achievable Scenario]; and**
- **Estimate the growth of the crumb rubber market in road surfacing applications and the potential that exists under an approach of mandated use by the various state road authorities based on the average use of 15% crumb rubber (CR) in all the bitumen used in Australia [Mandated Scenario]**

Terminology 1.3

In Australia bitumen modified using synthetic polymers and crumb rubber are collectively specified and referred as Polymer Modified Bitumen (PMB) or sometimes, collectively termed as “modified bitumen” or “modified binders”.

In this report binders using end of life (ELT) tyre derived crumb rubber is referred to as Crumb Rubber Modified Bitumen (CRMB). Where the neat bitumen (unmodified) is also included in the overall assessment of the market, the collective term “Bituminous Binders” is used.

Data reported 1.4

The analysis of the market share of CRMB is reported on a national and state basis based on market knowledge and projections in the consumption of neat bitumen from 2023 to 2026.

In a chronological order the report covers the following on a consolidated basis and individually for each state:

- Volume projections as a "**current scenario**" from 2023 to 2026 for CRMB and the component of crumb rubber used in the modification of bitumen in tonnes and the resultant ELTs expressed in EPUs.
- Volume projections as an "**achievable scenario**" from 2023 to 2026 considering an increased use in low level modified binders for sprayed sealing and in asphalt applications and the component of crumb rubber used in the modification of bitumen in tonnes and the resultant ELTs expressed in EPUs.
- Volume projections as a "**mandated scenario**" from 2023 to 2026 assuming a modification level of 15% addition of crumb rubber to every tonne of bitumen consumed and the component of crumb rubber used in the modification of bitumen in tonnes and the resultant ELTs expressed in EPUs.

Data Presentation 1.5

Data is presented for each of the scenarios for the period 2023 to 2026 and covers:

1. Volume of the neat bitumen market,
2. Volume of crumb rubber modified bitumen,
3. Quantity of crumb rubber consumed, and
4. The resultant end of life tyres treated in each of the state and on a national basis.

Market Understanding 2

Polymer Modified Bitumen (PMB) in Australia 2.1

As the traffic frequency and loading increased, the use of tyre derived crumb rubber and synthetic polymers in bitumen modification became the products of choice for applications requiring a specific performance, such as minimising cracking and fatigue failures, improving aggregate adhesion and designing pavements against permanent deformation.

The promotion of several types of polymers (and rubber) modified bitumen saw an introduction of the framework for the specification of Polymer Modified Bitumen (PMB) and subsequently the State Road Authorities (SRA) and Austroads (national) specification for PMBs. In Australia the specifications for crumb rubber modified bitumen (CRMB) are implicit in the specifications for PMBs and as such CRMB is referred as a PMB with a grade designation ending with 'R' implying rubber and other polymers designated 'E' for elastomeric polymers and 'P' for plastomeric polymers.

As the scope of the report is limited to CRMB, it will remain as the focus of the market analysis and projections.

Applications of Crumb Rubber Bitumen 2.2

Two main applications of crumb rubber modified bituminous binders in road surfacing and pavement construction are Sprayed Sealing and Asphalt

Sprayed Seal 2.2.1

A sprayed seal is a thin layer of binder sprayed onto a pavement surface with a layer of aggregate incorporated which is impervious to water. A Sprayed Seal is sometimes referred to as a "Spray Seal", a "Bitumen Seal" or a "Chip Seal". A hot mixture of bitumen (often with a cutter such as kerosene) is sprayed on the road surface by a tanker to form a thin waterproof membrane. The bituminous binder is then covered with a thin layer of aggregate with tip trucks. The aggregate is then embedded into the bitumen by rolling with a multi wheeled roller to form a skid resistant surface. The sealing aggregate consists of blue metal gravel with a nominal diameter of 7mm, 10mm or 14mm. Crumb rubber or polymer can be added to the bitumen to provide greater flexibility and strength.

There are several types of sprayed seals used in Australia, from single seals used in low traffic areas up to diverse special purpose seals for high traffic environments.

Crumb rubber in sprayed sealing can be used in the following surfacing:

High-Stress Seals (HSS)

These are used in areas subjected to frequent heavy traffic loads and moderate to high levels of stress, such as intersections, roundabouts, and steep gradients. HSS are suitable for areas with significant, but not extreme, stress due to braking, turning, or acceleration. In Victoria 5% crumb rubber by weight of bitumen is used to improve aggregate retention and a more resilient spray seal for low traffic.

- **High-Stress Seals commonly use 5% – 10% crumb rubber by weight of bitumen.**

Extreme-Stress Seals (XSS)

These are designed for the most demanding conditions, where the stress levels are extremely high. XSS are used in locations with very high traffic volumes, intense braking and turning actions, and severe climatic conditions, such as major intersections, high-volume traffic lanes, and areas prone to rapid temperature changes. Commonly 10% – 15% crumb rubber by weight of bitumen is used.

- **Extreme-Stress Seals commonly use 10% – 15% crumb rubber by weight of bitumen.**

Strain Alleviating Membrane (SAM)

This is a surface treatment used in pavement construction to retard the propagation of cracks from the underlying layers into the surface layer. SAM acts as a stress-absorbing layer that mitigates the impact of tensile stresses, which can lead to surface cracking. Typically, SAM consists of a modified binder sprayed onto the existing pavement, followed by a layer of aggregate.

The primary function of SAM is to absorb and dissipate stress, extending the life of the pavement by delaying the onset and propagation of surface cracks. It is commonly used in areas where surface cracking is a concern, such as in overlays of existing pavements that have begun to deteriorate. Used as surface sealing for cracked pavements, bridges or anywhere that reflective cracking or waterproofing is an important consideration.

- **Strain Alleviating Membrane typically use 15% – 18% crumb rubber by weight of bitumen.**

Strain Alleviating Membrane Interlayer (SAMI)

This serves a similar purpose to SAM but is placed between the existing pavement and a new overlay. SAMI acts as an interlayer to prevent the reflection of cracks from the existing pavement into the new overlay. It usually consists of a bitumen-rich layer, often with a modified binder, designed to act as a cushion between the old and new layers.

The main function of SAMI is to intercept and alleviate the stresses that cause reflective cracking, thereby enhancing the performance and extending the life of the overlay. SAMI is particularly useful in rehabilitation projects where a new asphalt overlay is applied over an existing pavement with significant cracking, ensuring that these cracks do not propagate through to the new surface, thus maintaining a smoother and more durable roadway. These products can contain high quantity of synthetic polymers or crumb rubber. Around 20% crumb rubber by weight of bitumen is used for this application.

- **Strain Alleviating Membrane Interlayer typically use ~20% crumb rubber by weight of bitumen.**

Asphalt

2.2.2

Asphalt is a composite material consisting of bituminous binder and mineral aggregate mixed together and then laid down at high temperatures in layers and compacted. An Asphalt Pavement is a pavement, in which the predominant structural strength is provided by asphalt layers. The use of bituminous binder ensures that the pavement remains flexible. A flexible pavement is a road pavement with a structure that deflects, or flexes, under loading.

A flexible pavement structure is typically composed of several layers of material. Each layer receives the loads from the above layer, spreads them out, and then passes on these loads to the next layer below.

Crumb rubber in asphalt can be used in the following surfacing:

Dense graded asphalt (DGA)

This is a type of asphalt concrete mixture characterized by a well-graded aggregate structure that provides a dense and impermeable surface. It is composed of a carefully balanced blend of coarse and fine aggregates, along with an asphalt binder that binds the aggregates together. This composition ensures that the voids between the aggregates are minimized, resulting in a strong, durable, and smooth pavement surface.

DGA is widely used in road construction due to its excellent load-bearing capacity, resistance to rutting, and ability to withstand various weather conditions. The dense structure of this asphalt mix also helps to reduce water infiltration, thereby enhancing the longevity of the pavement by minimizing damage from freeze-thaw cycles and moisture-related distresses. Additionally, dense graded asphalt provides a relatively quiet and smooth driving surface, making it a preferred choice for highways, urban streets, and other high-traffic areas.

The use of crumb tyre rubber in dense-graded asphalt mixes offers benefits such as enhanced elasticity, durability, and resistance to rutting and cracking, typically incorporating 10-20% crumb rubber by weight of the binder. However, significant design limitations must be addressed, particularly concerning the management of void content and the mix's compact-ability.

The addition of crumb rubber alters the binder's properties, affecting the air voids in the mixture and complicating the attainment of optimal void content. This can lead to difficulties in achieving proper compaction, as the rubber-modified binder requires specific handling to ensure uniform distribution and stability. These challenges necessitate precise adjustments in the mixing and compaction processes, often requiring higher temperatures and specialised equipment to ensure the asphalt's performance and longevity. Consequently, while crumb rubber enhances certain properties of asphalt, its integration demands meticulous mix design and control to overcome these limitations.

For the reasons highlighted above, modified binders in Australia for this application mainly utilise elastomeric or plastomeric polymers. However, the use of crumb rubber in DGA is prevalent in the USA, particularly in wearing course asphalt mixes for improved performance in heavy duty applications.

- **Dense graded asphalt typically incorporates 10-20% crumb rubber by weight of the binder.**

Open Graded Asphalt (OGA)

This a type of asphalt concrete is designed to have a high void content by using a uniform distribution of larger aggregate sizes and minimal fines. This composition creates a porous structure that allows water to drain through the pavement, reducing surface water and the risk of hydroplaning. The open texture also helps to minimize splash and spray from vehicles during wet conditions, improving driving safety. Additionally, OGA can reduce noise levels by absorbing sound energy, making it beneficial for urban areas and highways where noise pollution is a concern. Despite its benefits, OGA is typically less durable than dense graded asphalt and may require more frequent maintenance, as the open structure can be more susceptible to damage from heavy traffic and weather-related wear. It is often used in surface layers where drainage and noise reduction are prioritised.

Experience from the USA market suggests that usage of crumb rubber modified binder (wet mix process) using 15% to 18 % crumb rubber by weight of bitumen in open graded asphalt can result in a significant increase in durability and potential improvement in resistance to heavy traffic. Whilst this may lead to a decrease in porosity and increase in water spray, such mixes would still be expected to retain suitable texture depth and hence good skid resistance.

- **Experience from the USA market suggests that usage of crumb rubber modified binder (wet mix process) using 15% to 18 % crumb rubber by weight of bitumen in open graded asphalt.**

Gap Graded Asphalt (GGA)

This type of asphalt concrete mix features an aggregate distribution with certain size ranges intentionally omitted, creating a "gap" in the gradation curve. This design typically includes a higher proportion of coarse aggregates and a limited amount of fine particles, with a significant gap in the mid-sized aggregates. The resulting mixture provides a stone-on-stone contact that enhances the interlock between the aggregates, improving the structural integrity and resistance to deformation under heavy loads. Gap graded asphalt is known for its excellent durability and ability to resist rutting, making it suitable for high-stress environments such as intersections and heavy-traffic roads. The mix also allows for higher binder content, which can improve the flexibility and resistance to cracking. However, achieving the optimal mix can be more complex, requiring careful control of aggregate proportions and binder content to ensure consistent performance. Gap graded asphalt is often used in applications where both strength and durability are critical, offering a balance between dense graded and open graded asphalt properties.

- **Existing standards for GGA in Australia stipulate binders with modification levels between 18% and 22% of crumb rubber.**

Stone Mastic Asphalt (SMA)

SMA is a high-performance asphalt mixture designed to provide a durable and stable surface, particularly suited for roads with heavy traffic loads. Characterised by a high content of coarse aggregates, SMA features a stone-on-stone contact that forms a strong skeletal structure, enhancing its resistance to rutting and deformation. The mix also contains a rich mortar of asphalt binder, filler, and stabilizing additives such as fibers, which fill the voids and provide additional cohesion and durability. This composition results in a pavement that can effectively withstand the stresses of heavy vehicular traffic, extreme weather conditions, and temperature variations. SMA's superior properties make it an ideal choice for highways, intersections, and other high-stress areas, offering long-lasting performance with reduced maintenance needs. Additionally, its textured surface contributes to improved skid resistance and reduced road noise, enhancing safety and driving comfort.

The content of crumb rubber in Stone Mastic Asphalt (SMA) can vary depending on the specific mix design and performance requirements. Generally, the crumb rubber content in SMA is typically added in the range of 10% to 20% by weight of the asphalt binder.

An 18% -20% crumb rubber bitumen binder provides a comparable performance to a 5% SBS polymer modified binder. However, the virgin SBS polymers are in the order of five times (x 5) more expensive than the raw crumb rubber, this combined with the relativity of the price of bitumen versus crumb rubber provides an attractive economic and an environmental option in favour of crumb rubber modified bitumen.

- **Generally, the crumb rubber content in SMA is typically added in the range of 10% to 20% by weight of the asphalt binder.**

Based on the experience with crumb rubber in the USA and as a result of the study tours and technology transfer there have been several successful trials with crumb rubber in various asphalt applications. This has resulted in the evolution of the specifications and the technology is commercially ready and provides an encouraging outlook on the uptake of crumb rubber in asphalt applications. This supports the assumptions made in the achievable scenario projections.

CRMB Volume Projection Scenarios 3

The objective of this report is to provide an understanding of the market for crumb rubber in road surfacing applications and the potential moving forward.

There are several perspective to analyse in order to get an understanding and some form a perspective on the market. Essentially three areas of exploration; (i) what is the current market and how is it going to grow? (ii) what is achievable in the event of increased uptake of crumb rubber? and (iii) what is the market in an optimistic mode of a mandate being imposed by regulators? These three scenarios are designated as "Current", "Achievable" and "Mandated and provide a good understanding of the market potential and the resulting treatment of the end-of-life tyres.

Current Scenario 3.1

Volume projections given by the current market are based on the combination of the historic growth trajectories and the current understanding of the direction being adopted by the road authorities in all forms of the government to push the sustainability agenda. The volume projection under the current scenario is based on computing the historic increases in the market and forward forecasting the trends. A fair understanding and experience in the market including any intelligence is crucial in projections.

Achievable Scenario 3.2

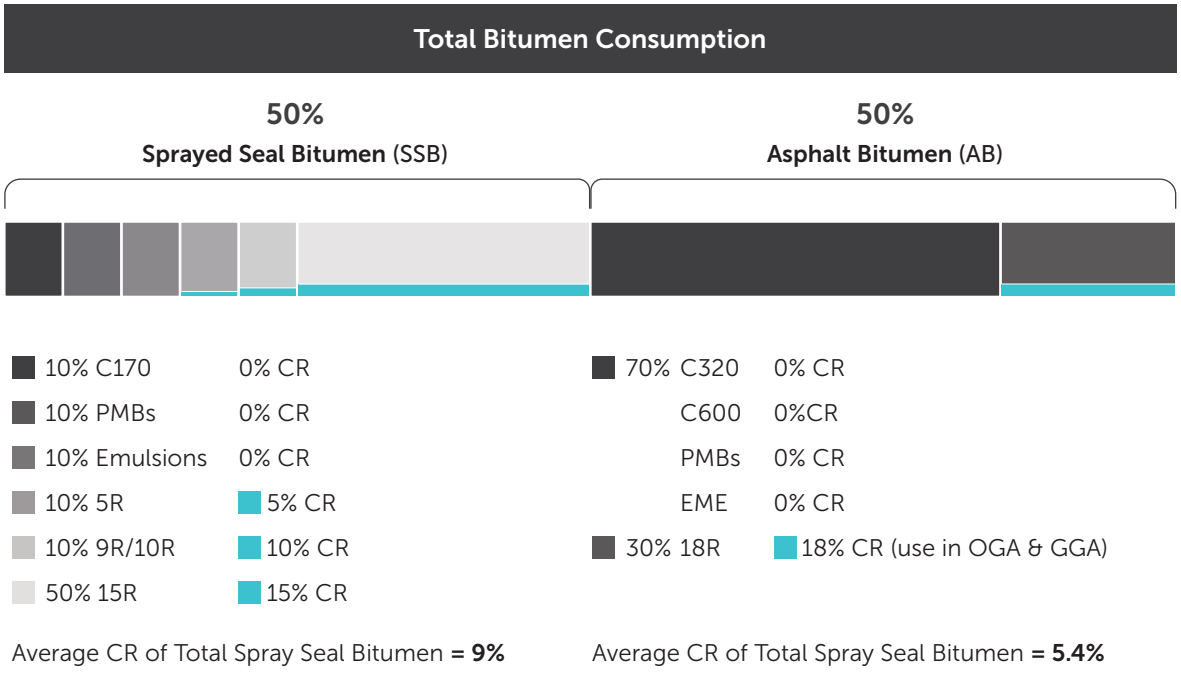
The Achievable Scenario is predicated on increased uptake of crumb rubber in asphalt applications and in a potential of a widespread use of low levels (5%) of crumb rubber in sprayed sealing. There is a trend of increasing usage of crumb rubber in asphalt, specifically in gap graded and open graded asphalt. To be able to predict the potential of crumb rubber in these asphalt applications and in absence of the data split available for the two applications, certain assumptions need to be made regarding the total asphalt market makeup and the split in each type of asphalt mix used. As a general understanding it is commonly stipulated that 50% of the total bitumen consumed is used in asphalt and the remaining 50% in sprayed sealing.

The generic (applied to all states) achievable volumes have been predicted by calculations using the following assumptions as input:

- Of the total bitumen market, 50% bitumen is used in sprayed sealing applications and 50% bitumen is used in asphalt applications
- Of the total bitumen used in sprayed sealing applications and related products, 65% will have crumb rubber of varying percentages and 35% of the bitumen will remain with no crumb rubber. The crumb rubber excluding products likely to remain in use in sprayed sealing include; neat C170 bitumen, PMBs using synthetic polymers and bitumen emulsions.
- Of the 65% sprayed sealing bitumen that will have crumb rubber, 10% of this will have 5%CR, 10% of this will have 10%CR and 50% of this will have 15%CR. On this basis the average CR of the total sprayed seal bitumen equates to 9.0%
- Of the total asphalt used, 70% of the asphalt, mainly DGA will remain with no crumb rubber and 30% of the asphalt, mainly gap graded and open graded, will have crumb rubber at the level of 18% of the bitumen content. The crumb rubber excluding products likely to remain in use in asphalt include; neat C320, C450, C600, EME bitumen and PMBs using synthetic polymers.

- Of the 30% asphalt bitumen that will have crumb rubber, all of this will have 18% CR. To allow for contingencies (sometimes amounts , 18% may be used) a figure of 15% has been adopted. On this basis the average CR of the total asphalt bitumen equates to 5.4%
- Considering all of the above the average CR of the total bitumen (sprayed sealing plus asphalt) consumed equates to 7.2% (refer to Figure 1)

Figure 1 : Assumptions used to model the **achievable scenario** projections for Crumb Rubber use in road surfacing applications:



Average Crumb Rubber of Total Bitumen Consumption = 7.2%

Key result – Achievable Scenario

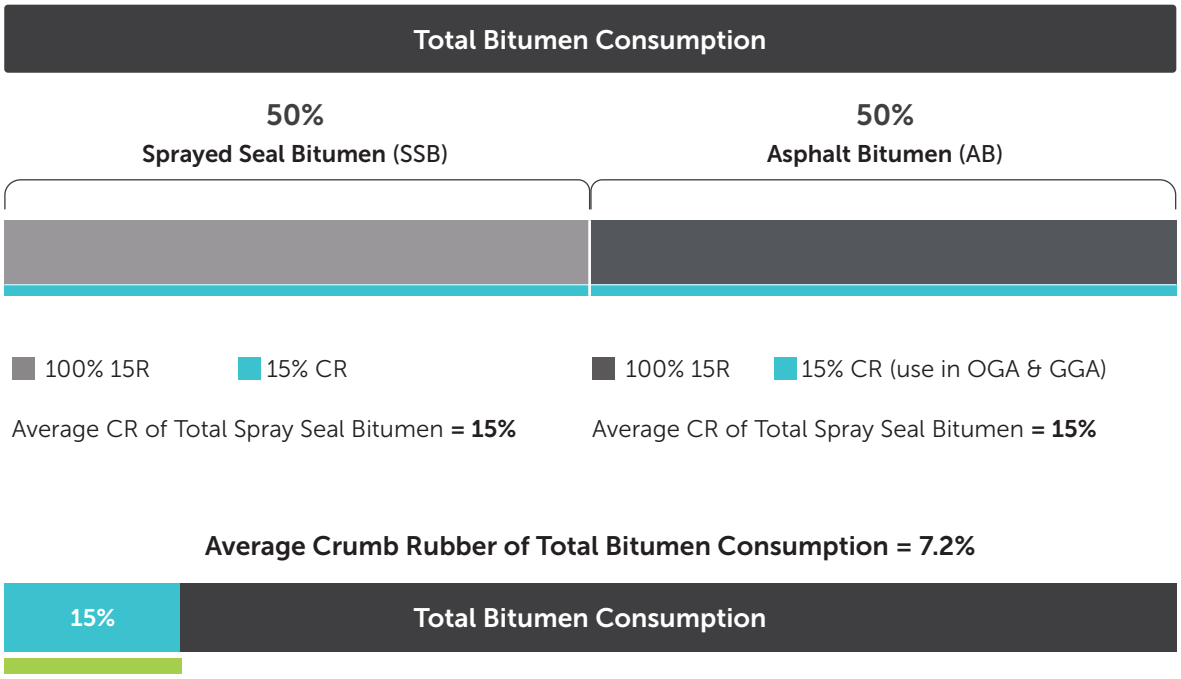
- **7.2% Crumb Rubber use equates to an additional ~12.7 million EOLT EPU consumed on 2023 current scenario**

Mandated Scenario

3.3

The volume projections under the mandate scenario are predicated on the basis that all the bitumen consumed nationally must have 15% crumb rubber (refer to Figure 2).

Figure 2: Assumptions used to model the **mandated scenario** projections for Crumb Rubber use in road surfacing applications:



Key result – Mandated Scenario

- **15% Crumb Rubber use equates to an additional ~26.5 million EOLT EPU consumed on 2023 current scenario**

CRMB Volume Projections - Australia

4

Current Scenario - Australia

4.1

- **The overall estimated neat bitumen market in 2023 in Australia was in the order of 998,018 tonnes.**

It is estimated that in 2023, 16.64% (166,075 tonnes) of the total bitumen used in Australia was modified using crumb rubber, with the crumb rubber component being 24,911 tonnes, equivalent to 4,151,875 EPUs.

There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Australia will be 1,059,104 tonnes of which 19.69% (208,500 tonnes) of it modified using crumb rubber with the crumb rubber component being 31,275 tonnes equivalent to 5,212,500 EPUs. Refer to Figure 3 for projections for the years 2023 to 2026.

Current Scenario – Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**998,018**	1,017,978	1,038,337	**1,059,104**
CRMB Usage (tonnes)	**166,075**	179,100	193,300	**208,500**
CRMB Usage, % of overall bitumen used	**16.64%**	17.59%	18.62%	**19.69%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**24,911**	26,865	28,995	**31,275**
Crumb Rubber Component, % of overall bitumen used	**2.50%**	2.64%	2.79%	**2.95%**
EOLT @ 6 kgs CR per unit (EPUs)	**4,151,875**	4,477,500	4,832,500	**5,212,500**

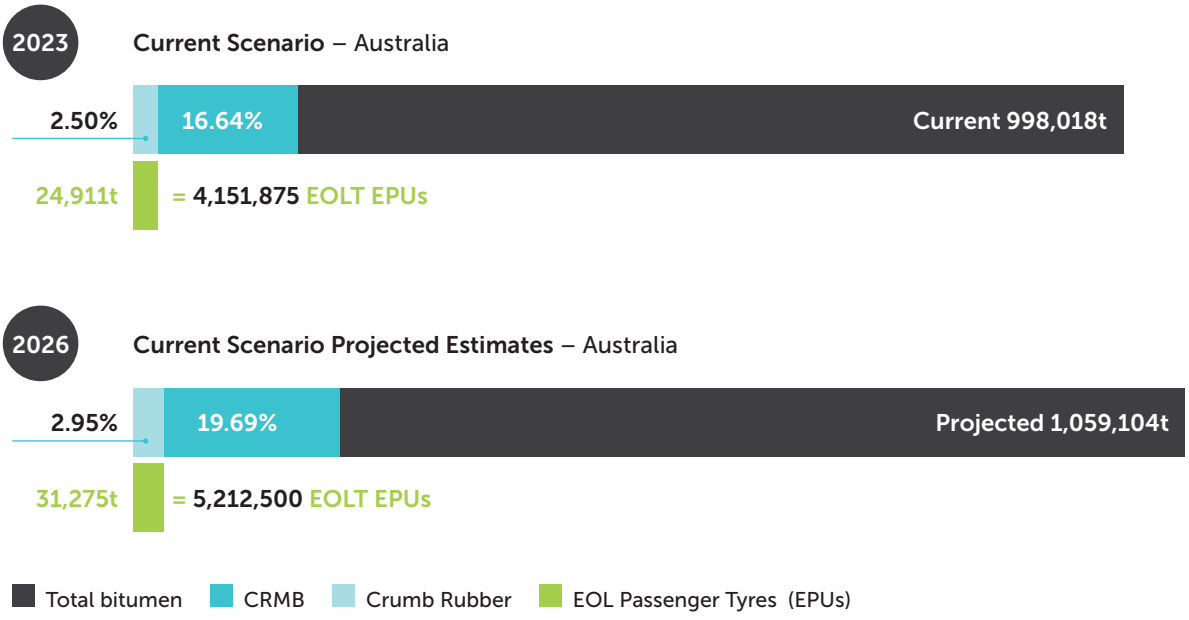


Figure 3: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – Australia

Achievable Scenario - Australia

4.2

Under the achievable scenario, it is estimated that in 2023, 48% (479,049 tonnes) of the total bitumen used in Australia would have been modified using crumb rubber, with the crumb rubber component being 71,857 tonnes equivalent to 11,976,216 EPUs.

It is projected that in 2026, for the neat bitumen market in Australia of 1,059,104 tonnes and 48% (508,370 tonnes) of it modified using crumb rubber, the crumb rubber component would be 76,255 tonnes equivalent to 12,709,248 EPUs. Refer to Figure 4 for projections for the years 2023 to 2026.

Achievable Scenario – Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**998,018**	1,017,978	1,038,337	**1,059,104**
CRMB Usage (tonnes)	**479,049**	488,629	498,402	**508,370**
CRMB Usage, % of overall bitumen used	**48%**	48%	48%	**48%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**71,857**	73,294	74,760	**76,255**
Crumb Rubber Component, % of overall bitumen used	**7.2%**	7.2%	7.2%	**7.2%**
EOLT @ 6 kgs CR per unit (EPUs)	**11,976,216**	12,215,736	12,460,044	**12,709,248**

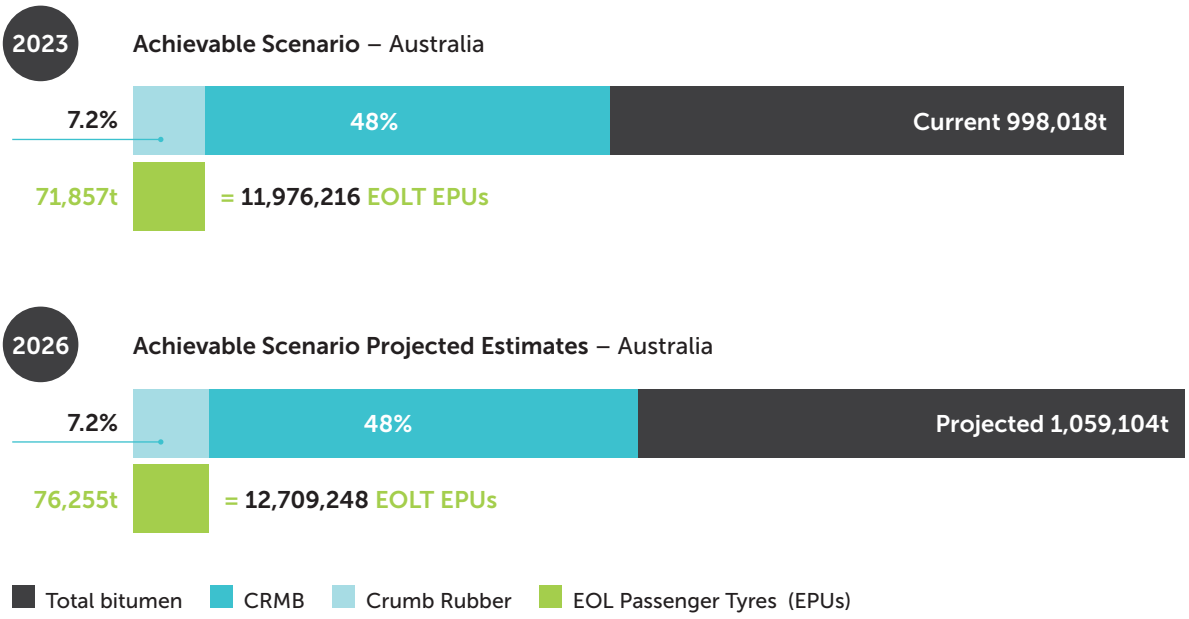


Figure 4: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – Australia

Key result – Achievable Scenario

- **Consumption of an additional ~8.5 million EOLT EPU on 2023 current scenario**

Mandated Scenario - Australia

4.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (998,018 tonnes) consumed in road surfacing applications in 2023, it is estimated that 149,703 tonnes of crumb rubber would have been consumed equivalent to 24,950,439 EPUs. It is projected bitumen market in Australia in 2026 is expected to be 1,059,104 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 158,866 tonnes of crumb rubber would be consumed equivalent to 26,477,605 EPUs. Refer to Figure 5 for projections for the years 2023 to 2026.

Mandated Scenario – Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**998,018**	1,017,978	1,038,337	**1,059,104**
CRMB Usage (tonnes)	**998,018**	1,017,978	1,038,337	**1,059,104**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**149,703**	152,697	155,751	**158,866**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**24,950,450**	25,449,450	25,958,425	**26,477,600**

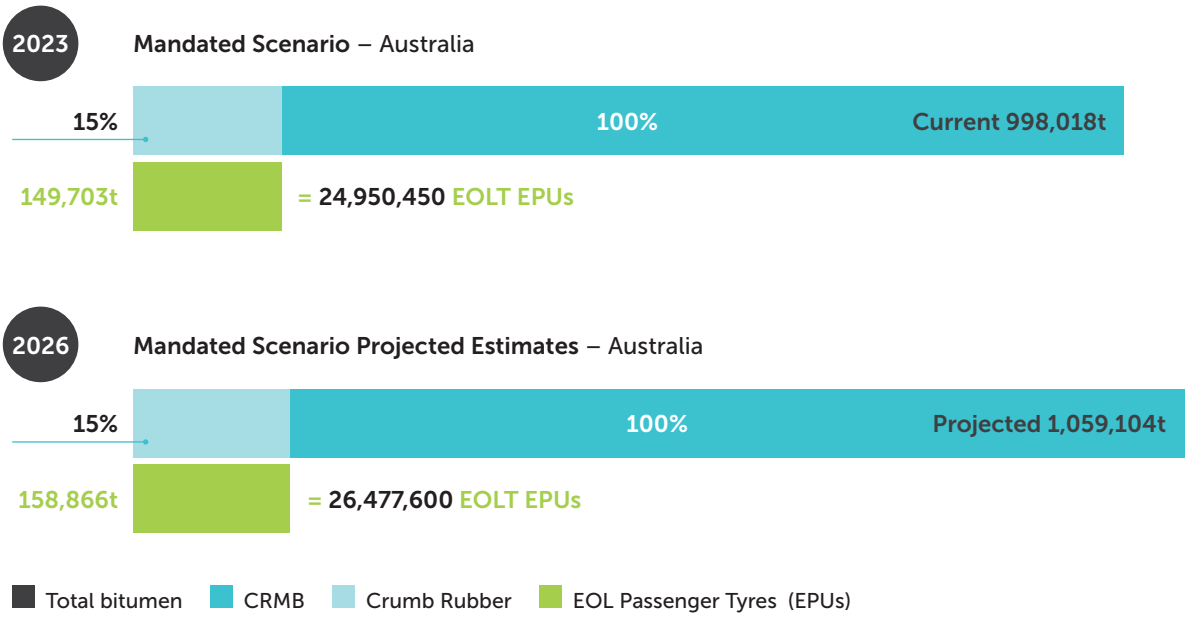


Figure 5: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – Australia

Mandated Scenario – Key Result

- **Consumption of an additional ~22.3 million EOLT EPU on 2023 current scenario**

CRMB Volume Projections – NSW

5

Current Scenario – New South Wales

5.1

- **The overall estimated neat bitumen market in 2023 in NSW was in the order of 231,566 tonnes.**

It is estimated that in 2023, 17.28% (40,013 tonnes) of the total bitumen used in NSW was modified using crumb rubber, with the crumb rubber component being 6,002 tonnes, equivalent to 1,000,325 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in NSW will be 245,740 tonnes of which 19.54% (48,015 tonnes) of it modified using crumb rubber with the crumb rubber component being 7,202 tonnes equivalent to 1,200,375 EPUs. Refer to Figure 6 for projections for the years 2023 to 2026.

Current Scenario – New South Wales	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**231,566**	236,197	240,921	**245,740**
CRMB Usage (tonnes)	**40,013**	41,710	44,863	**48,015**
CRMB Usage, % of overall bitumen used	**17.28%**	17.66%	18.62%	**19.54%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**6,002**	6,257	6,729	**7,202**
Crumb Rubber Component, % of overall bitumen used	**2.59%**	2.65%	2.79%	**2.93%**
EOLT @ 6 kgs CR per unit (EPUs)	**1,000,325**	1,042,750	1,121,575	**1,200,375**

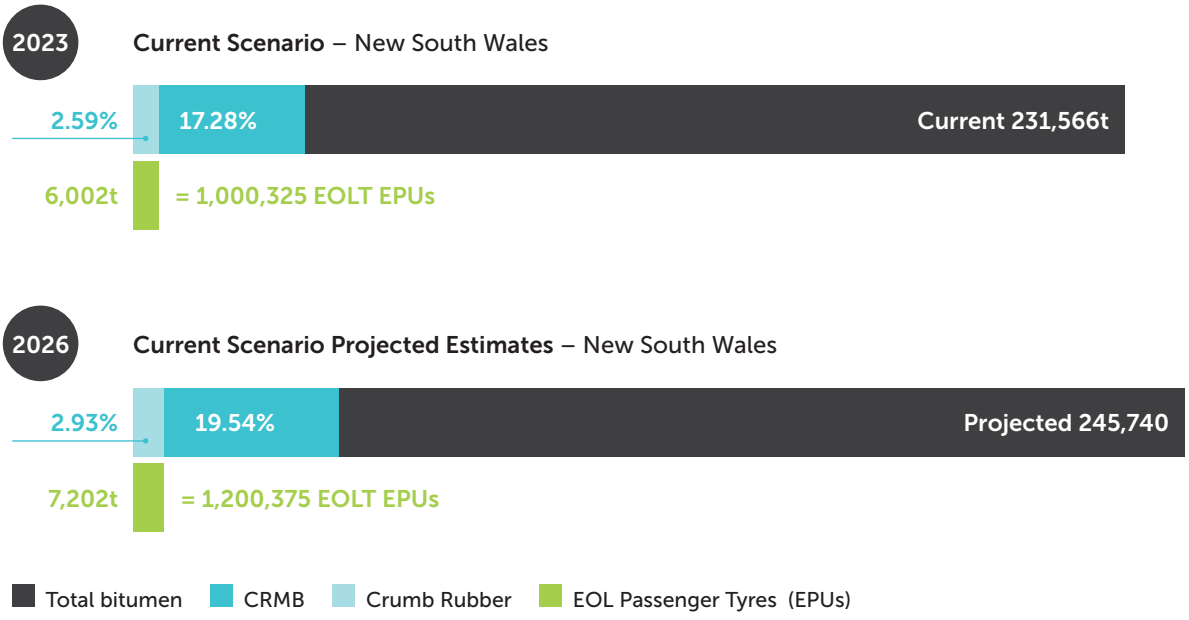


Figure 6: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – NSW

Achievable Scenario - New South Wales

5.2

Under the achievable scenario, it is estimated that in 2023, 48% (111,152 tonnes) of the total bitumen used in NSW would have been modified using crumb rubber, with the crumb rubber component being 16,673 tonnes equivalent to 2,778,792 EPUs. It is projected that in 2026, for the neat bitumen market in NSW of 245,740 tonnes and 48% (117,955 tonnes) of it modified using crumb rubber, the crumb rubber component would be 17,693 tonnes equivalent to 2,948,880 EPUs. Refer to Figure 7 for projections for the years 2023 to 2026.

Achievable Scenario – New South Wales	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	231,566	236,197	240,921	245,740
CRMB Usage (tonnes)	111,152	113,375	115,642	117,955
CRMB Usage, % of overall bitumen used	48%	48%	48%	48%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	16,673	17,006	17,346	17,693
Crumb Rubber Component, % of overall bitumen used	7.2%	7.2%	7.2%	7.2%
EOLT @ 6 kgs CR per unit (EPUs)	2,778,792	2,834,364	2,891,052	2,948,880

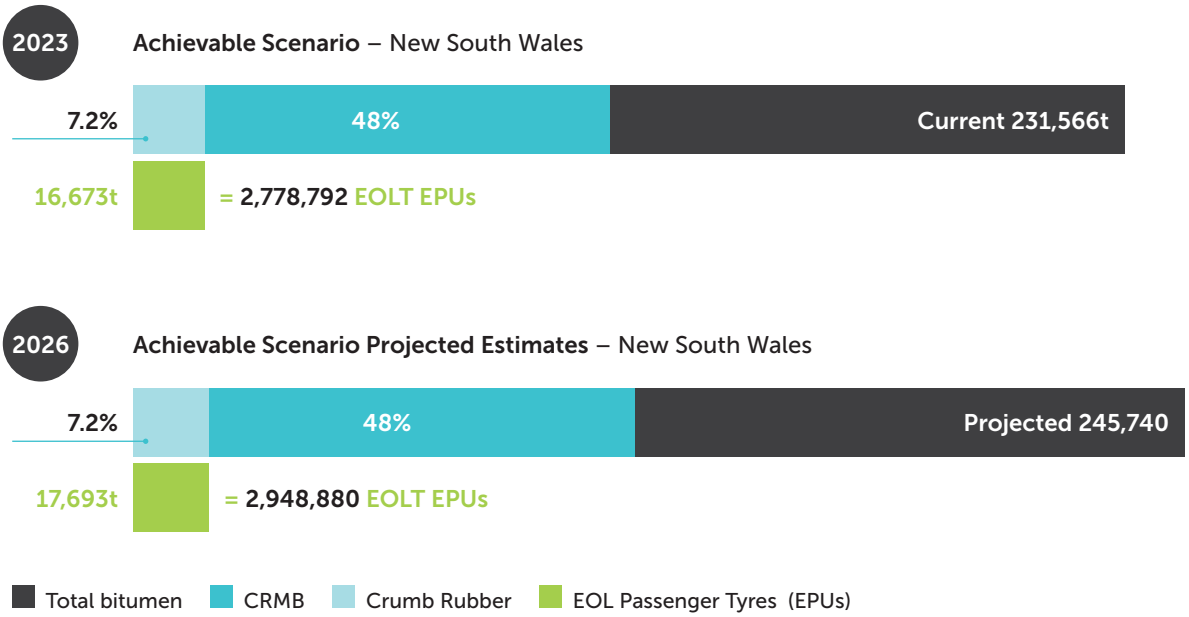


Figure 7: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – NSW

Achievable Scenario – Key Result

- **Consumption of an additional ~1.9 million EOLT EPU on 2023 current scenario**

Mandated Scenario - New South Wales

5.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (231,566 tonnes) consumed in road surfacing applications in 2023, it is estimated that 34,735 tonnes of crumb rubber would have been consumed equivalent to 5,789,150 EPUs. It is projected bitumen market in NSW in 2026 is expected to be 245,740 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 36,861 tonnes of crumb rubber would be consumed equivalent to 6,143,500 EPUs. Refer to Figure 8 for projections for the years 2023 to 2026.

Mandated Scenario – New South Wales	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**231,566**	236,197	240,921	**245,740**
CRMB Usage (tonnes)	**231,566**	236,197	240,921	**245,740**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**34,735**	35,430	36,138	**36,861**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**5,789,150**	5,904,925	6,023,025	**6,143,500**

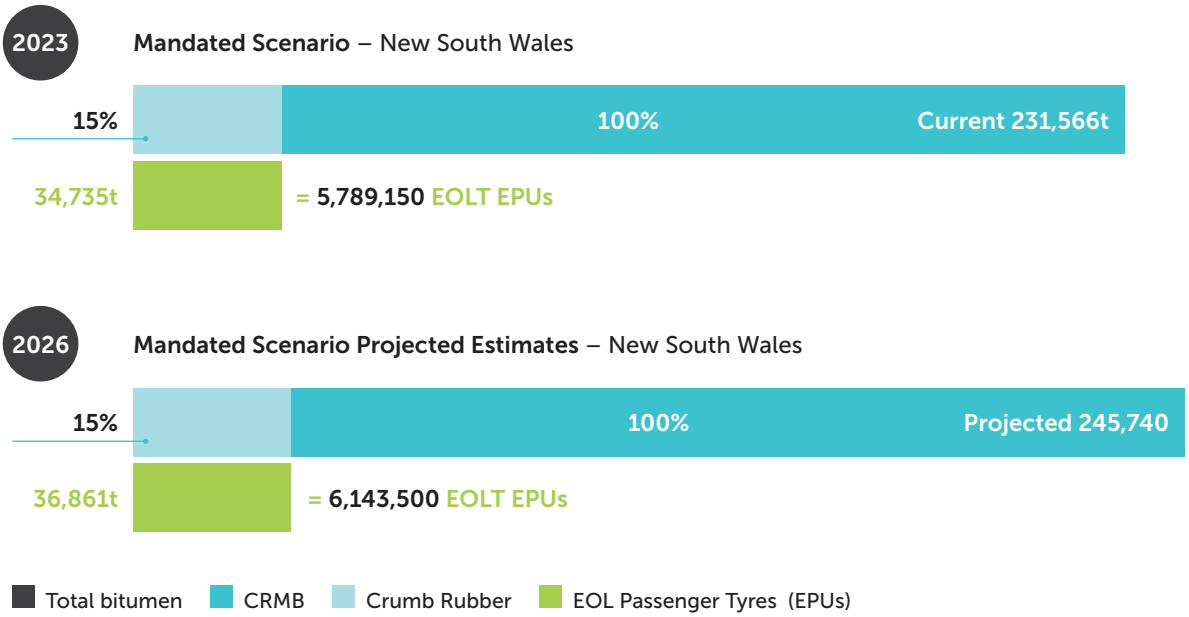


Figure 8: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – NSW

Mandated Scenario – Key Result

- **Consumption of an additional ~5.1 million EOLT EPU on 2023 current scenario**

CRMB Volume Projections - Victoria

6

Current Scenario – Victoria

6.1

- **The overall estimated neat bitumen market in 2023 in Victoria was in the order of 214,855 tonnes.**

It is estimated that in 2023, 24.05% (51,673 tonnes) of the total bitumen used in Victoria was modified using crumb rubber, with the crumb rubber component being 7,751 tonnes, equivalent to 1,291,825 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Victoria will be 228,006 tonnes of which 26.32% (60,000 tonnes) of it modified using crumb rubber with the crumb rubber component being 9,000 tonnes equivalent to 1,500,000 EPUs. Refer to Figure 9 for projections for the years 2023 to 2026.

Current Scenario – Victoria	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**214,855**	219,152	223,535	**228,006**
CRMB Usage (tonnes)	**51,673**	53,500	56,750	**60,000**
CRMB Usage, % of overall bitumen used	**24.05%**	24.41%	25.39%	**26.32%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**7,751**	8,025	8,513	**9,000**
Crumb Rubber Component, % of overall bitumen used	**3.61%**	3.66%	3.81%	**3.95%**
EOLT @ 6 kgs CR per unit (EPUs)	**1,291,825**	1,337,500	1,418,750	**1,500,000**

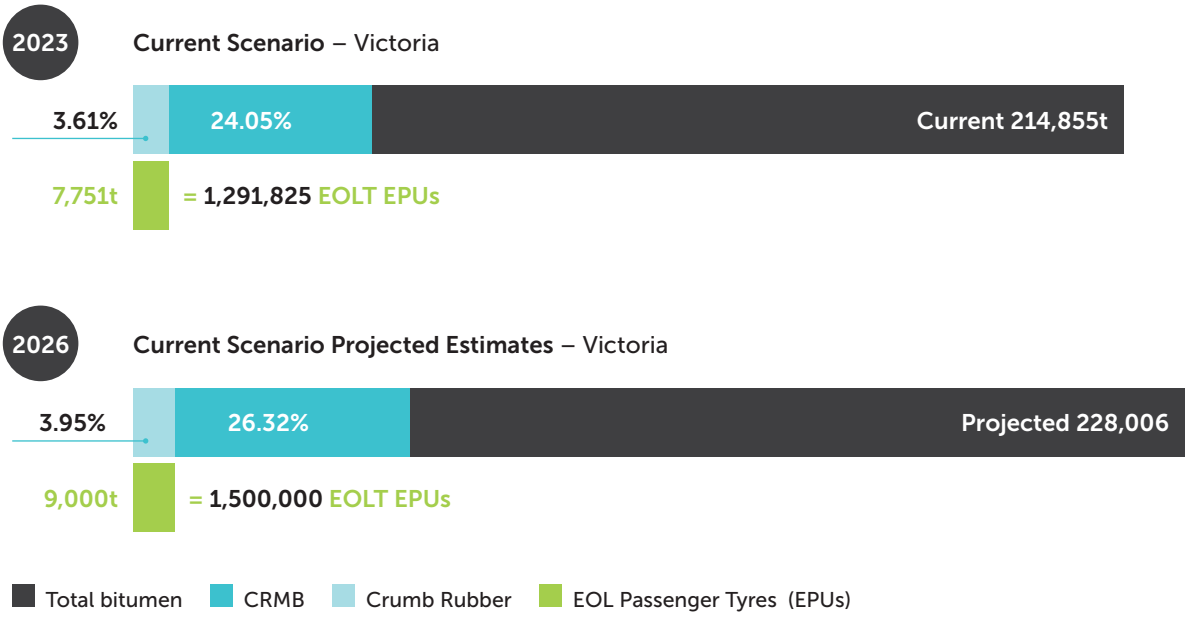


Figure 9: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – VIC

Achievable Scenario - Victoria

6.2

Under the achievable scenario, it is estimated that in 2023, 48% (103,130 tonnes) of the total bitumen used in Victoria would have been modified using crumb rubber, with the crumb rubber component being 15,470 tonnes equivalent to 2,578,260 EPUs. It is projected that in 2026, for the neat bitumen market in Victoria of 228,006 tonnes and 48% (109,443 tonnes) of it modified using crumb rubber, the crumb rubber component would be 16,416 tonnes equivalent to 2,736,072 EPUs. Refer to Figure 10 for projections for the years 2023 to 2026.

Achievable Scenario – Victoria	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	214,855	219,152	223,535	228,006
CRMB Usage (tonnes)	103,130	105,193	107,297	109,443
CRMB Usage, % of overall bitumen used	48%	48%	48%	48%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	15,470	15,779	16,095	16,416
Crumb Rubber Component, % of overall bitumen used	7.2%	7.2%	7.2%	7.2%
EOLT @ 6 kgs CR per unit (EPUs)	2,578,260	2,629,824	2,682,420	2,736,072

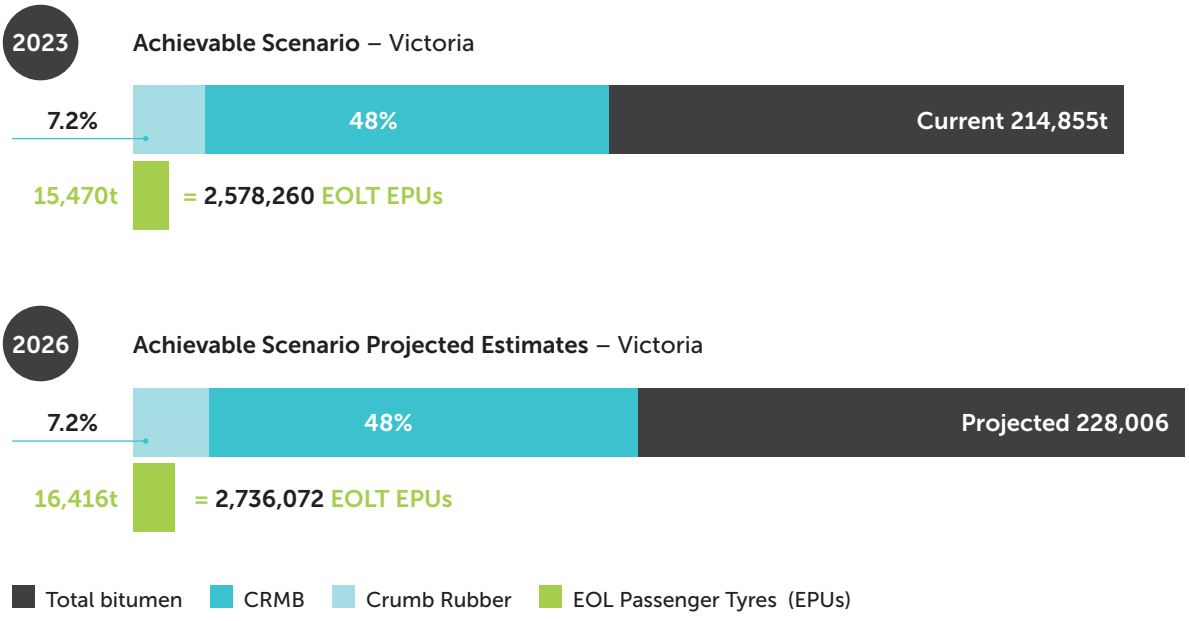


Figure 10: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – VIC

Achievable Scenario – Key Result

- **Consumption of an additional ~1.4 million EOLT EPU on 2023 current scenario**

Mandated Scenario - Victoria

6.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (214,855 tonnes) consumed in road surfacing applications in 2023, it is estimated that 32,228 tonnes of crumb rubber would have been consumed equivalent to 5,371,375 EPUs. It is projected bitumen market in Victoria in 2026 is expected to be 228,006 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 34,201 tonnes of crumb rubber would be consumed equivalent to 5,700,150 EPUs. Refer to Figure 11 for projections for the years 2023 to 2026

Mandated Scenario – Victoria	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**214,855**	219,152	223,535	**228,006**
CRMB Usage (tonnes)	**214,855**	219,152	223,535	**228,006**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**32,228**	32,873	33,530	**34,201**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**5,371,375**	5,478,800	5,588,375	**5,700,150**

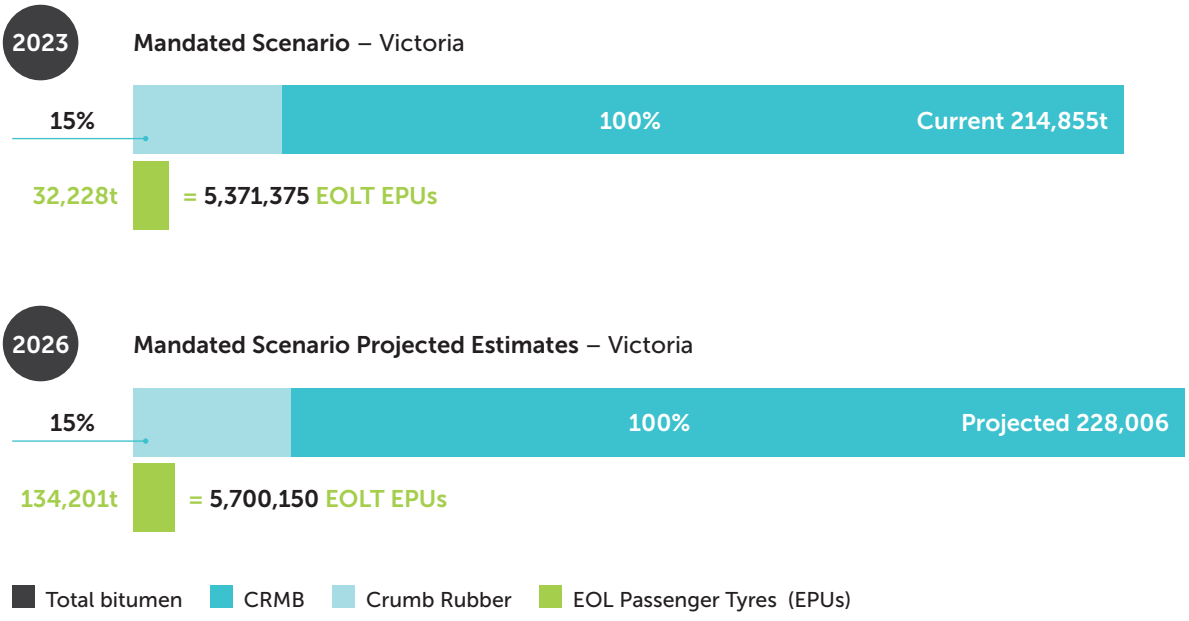


Figure 11: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – VIC

Mandated Scenario – Key Result

- **Consumption of an additional ~4.4 million EOLT EPU on 2023 current scenario**

CRMB Volume Projections - Queensland 7

Current Scenario – Queensland 7.1

- **The overall estimated neat bitumen market in 2023 in Queensland was in the order of 310,346 tonnes.**

It is estimated that in 2023, 13.29% (41,250 tonnes) of the total bitumen used in Queensland was modified using crumb rubber, with the crumb rubber component being 6,188 tonnes, equivalent to 1,031,250 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Queensland will be 329,342 tonnes of which 14.88% (49,000 tonnes) of it modified using crumb rubber with the crumb rubber component being 7,350 tonnes equivalent to 1,225,000 EPUs. Refer to Figure 12 for projections for the years 2023 to 2026.

Current Scenario – Queensland	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**310,346**	316,553	322,884	**329,342**
CRMB Usage (tonnes)	**41,250**	43,500	46,250	**49,000**
CRMB Usage, % of overall bitumen used	**13.29%**	13.74%	14.32%	**14.88%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**6,188**	6,525	6,938	**7,350**
Crumb Rubber Component, % of overall bitumen used	**1.99%**	2.06%	2.15%	**2.23%**
EOLT @ 6 kgs CR per unit (EPUs)	**1,031,250**	1,087,500	1,156,250	**1,225,000**

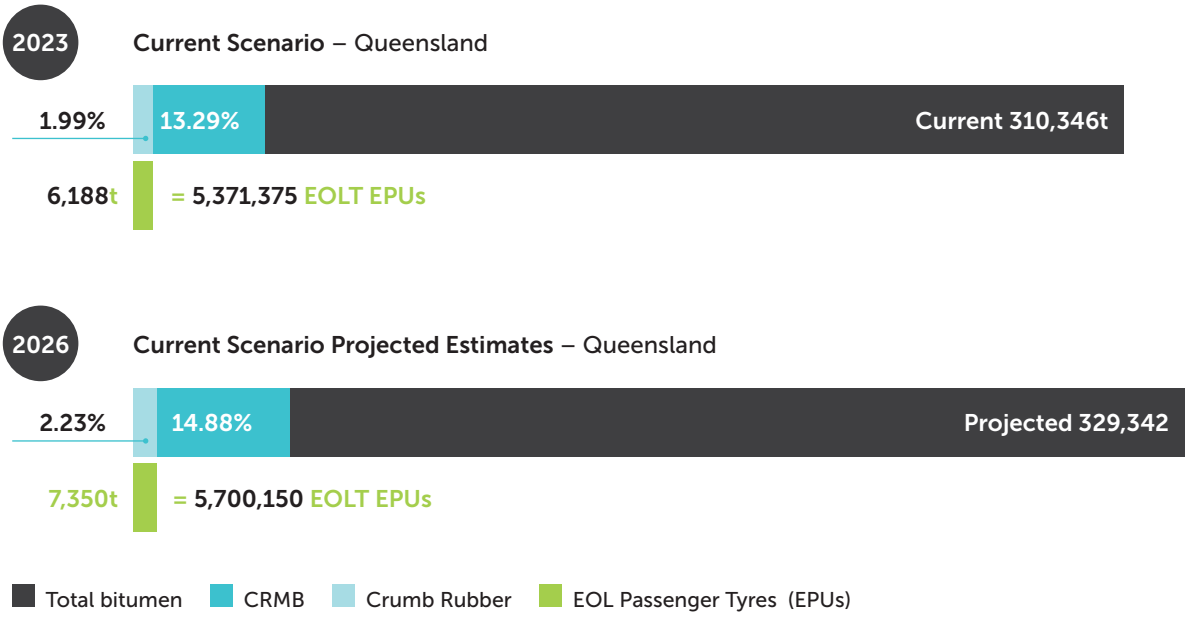


Figure 12: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – QLD

Achievable Scenario - Queensland

7.2

Under the achievable scenario, it is estimated that in 2023, 48% (148,966 tonnes) of the total bitumen used in Queensland would have been modified using crumb rubber, with the crumb rubber component being 22,345 tonnes equivalent to 3,724,152 EPUs. It is projected that in 2026, for the neat bitumen market in Queensland of 329,342 tonnes and 48% (158,084 tonnes) of it modified using crumb rubber, the crumb rubber component would be 23,713 tonnes equivalent to 3,952,104 EPUs. Refer to Figure 13 for projections for the years 2023 to 2026.

Achievable Scenario – Queensland	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**310,346**	316,553	322,884	**329,342**
CRMB Usage (tonnes)	**148,966**	151,945	154,984	**158,084**
CRMB Usage, % of overall bitumen used	**48%**	48%	48%	**48%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**22,345**	22,792	23,248	**23,713**
Crumb Rubber Component, % of overall bitumen used	**7.2%**	7.2%	7.2%	**7.2%**
EOLT @ 6 kgs CR per unit (EPUs)	**3,724,152**	3,798,636	3,874,608	**3,952,104**

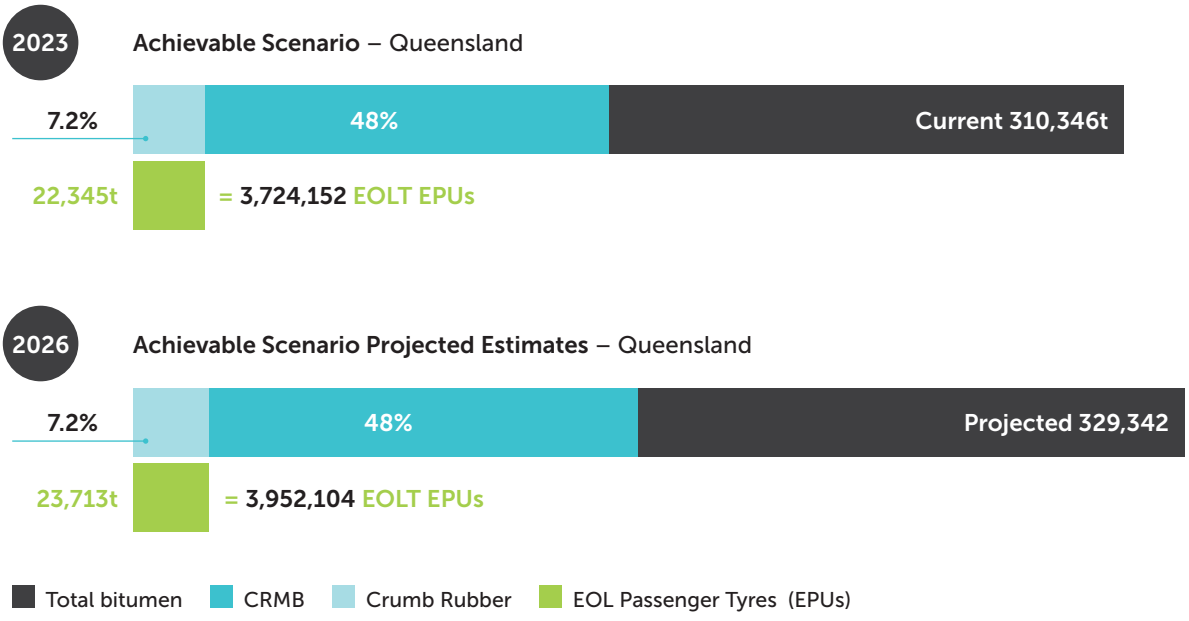


Figure 13: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – QLD

Achievable Scenario – Key Result

- **Consumption of an additional ~2.9 million EOLT EPU on 2023 current scenario**

Mandated Scenario - Queensland

7.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (310,346 tonnes) consumed in road surfacing applications in 2023, it is estimated that 46,552 tonnes of crumb rubber would have been consumed equivalent to 7,758,650 EPUs. It is projected bitumen market in Queensland in 2026 is expected to be 329,342 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 49,401 tonnes of crumb rubber would be consumed equivalent to 8,233,550 EPUs. Refer to Figure 14 for projections for the years 2023 to 2026

Mandated Scenario – Queensland	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**310,346**	316,553	322,884	**329,342**
CRMB Usage (tonnes)	**310,346**	316,553	322,884	**329,342**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**46,552**	47,483	48,433	**49,401**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**7,758,650**	7,913,825	8,072,100	**8,233,550**

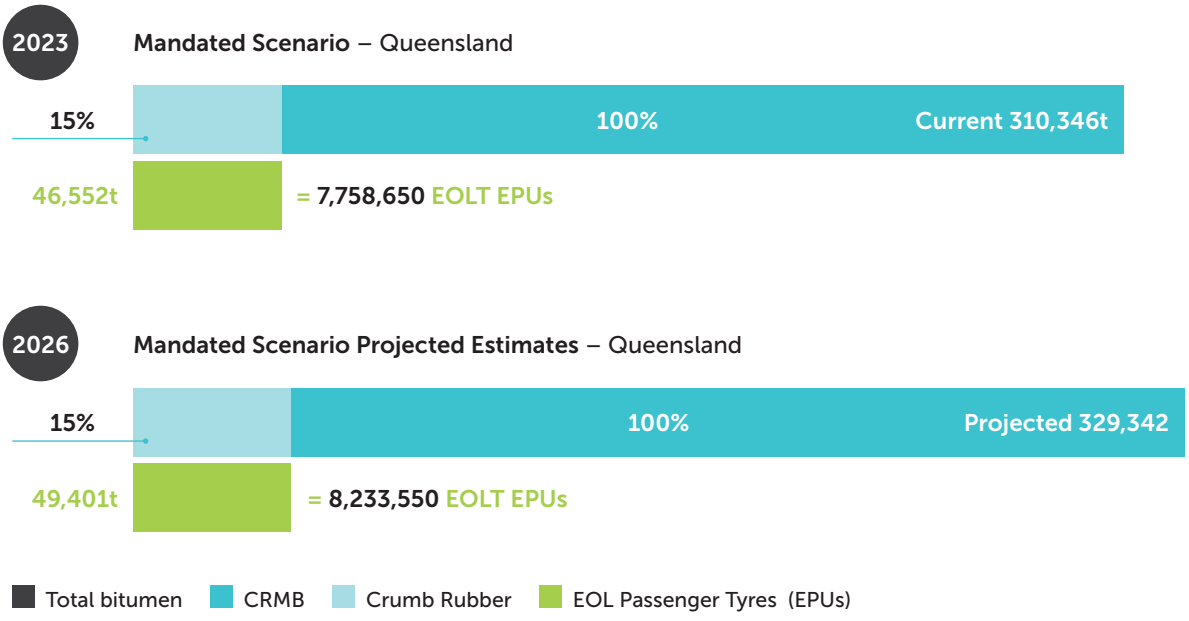


Figure 14: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – QLD

Mandated Scenario – Key Result

- **Consumption of an additional ~7.2 million EOLT EPU on 2023 current scenario**

CRMB Volume Projections – Western Australia 8

Current Scenario – Western Australia 8.1

- **The overall estimated neat bitumen market in 2023 in Western Australia was in the order of 131,300 tonnes.**

It is estimated that in 2023, 15.8% (20,750 tonnes) of the total bitumen used in Western Australia was modified using crumb rubber, with the crumb rubber component being 3,113 tonnes, equivalent to 518,750 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Western Australia will be 139,337 tonnes of which 20.81% (29,000 tonnes) of it modified using crumb rubber with the crumb rubber component being 4,350 tonnes equivalent to 725,000 EPUs. Refer to Figure 15 for projections for the years 2023 to 2026.

Current Scenario – Western Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**131,300**	133,926	136,605	**139,337**
CRMB Usage (tonnes)	**20,750**	23,500	26,250	**29,000**
CRMB Usage, % of overall bitumen used	**15.80%**	17.55%	19.22%	**20.81%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**3,113**	3,525	3,938	**4,350**
Crumb Rubber Component, % of overall bitumen used	**2.37%**	2.63%	2.88%	**3.12%**
EOLT @ 6 kgs CR per unit (EPUs)	**518,750**	587,500	656,250	**725,000**

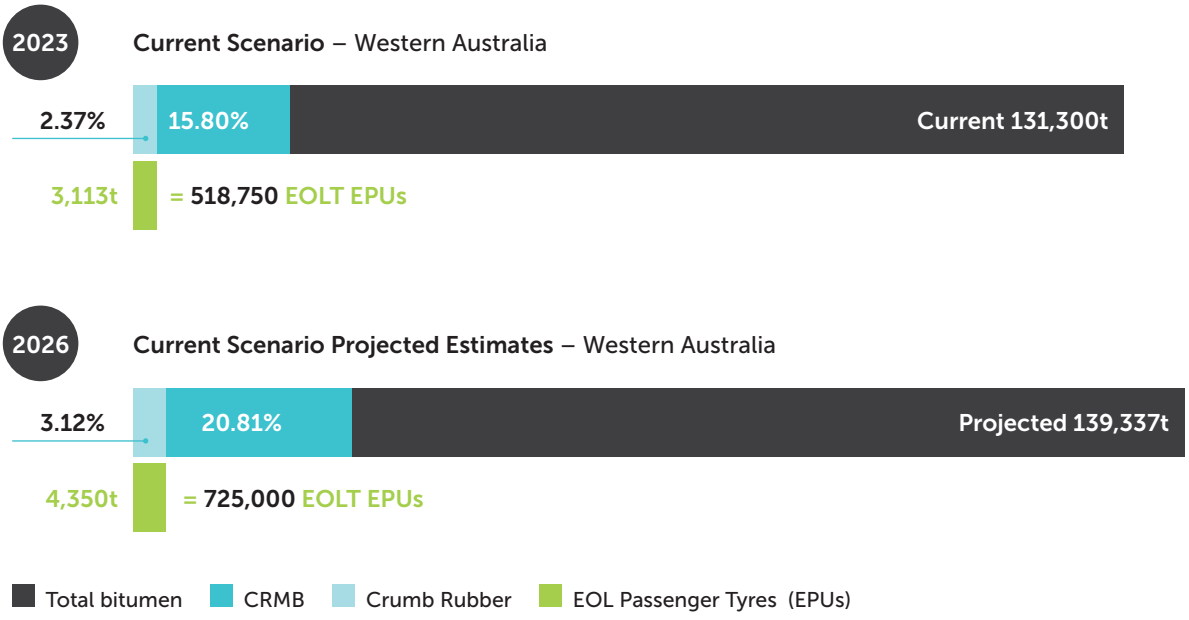


Figure 15: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – WA

Achievable Scenario - Western Australia

8.2

Under the achievable scenario, it is estimated that in 2023, 48% (63,024 tonnes) of the total bitumen used in Western Australia would have been modified using crumb rubber, with the crumb rubber component being 9,454 tonnes equivalent to 1,575,604 EPUs. It is projected that in 2026, for the neat bitumen market in Western Australia of 139,337 tonnes and 48% (66,882 tonnes) of it modified using crumb rubber, the crumb rubber component would be 10,032 tonnes equivalent to 1,672,043 EPUs. Refer to Figure 16 for projections for the years 2023 to 2026.

Achievable Scenario – Western Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**131,300**	133,926	136,605	**139,337**
CRMB Usage (tonnes)	**63,024**	64,285	65,570	**66,882**
CRMB Usage, % of overall bitumen used	**48%**	48%	48%	**48%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**9,454**	9,643	9,836	**10,032**
Crumb Rubber Component, % of overall bitumen used	**7.2%**	7.2%	7.2%	**7.2%**
EOLT @ 6 kgs CR per unit (EPUs)	**1,575,604**	1,607,116	1,639,258	**1,672,043**

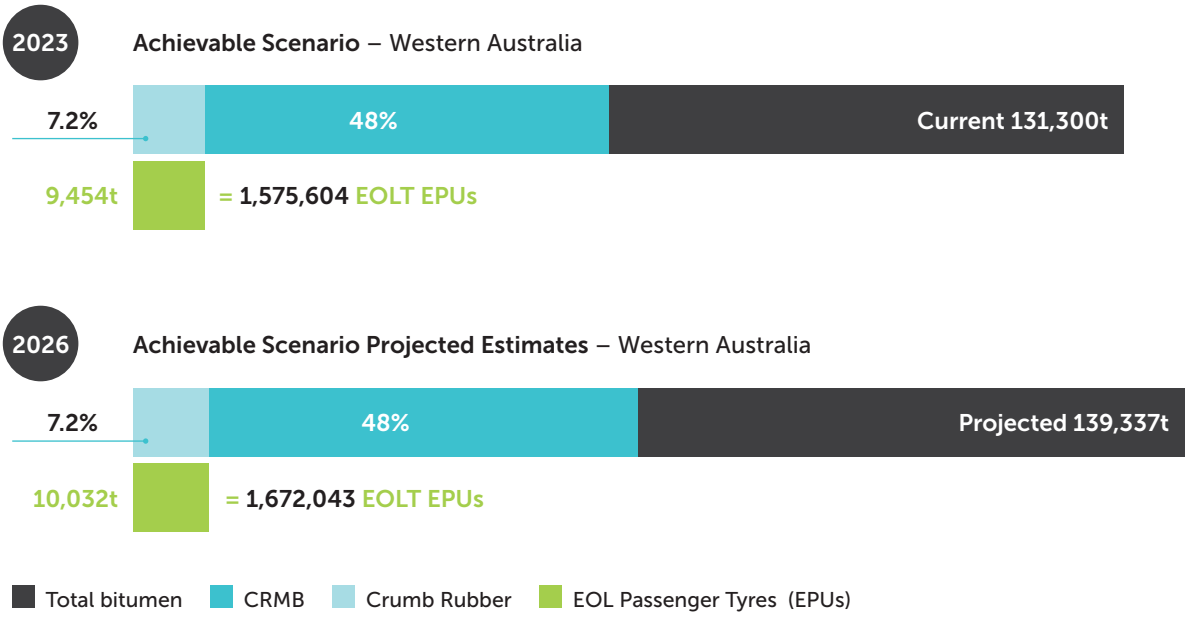


Figure 16: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – WA

Achievable Scenario – Key Result

- **Consumption of an additional ~1.1 million EOLT EPU on 2023 current scenario**

Mandated Scenario - Western Australia

8.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (131,300 tonnes) consumed in road surfacing applications in 2023, it is estimated that 19,695 tonnes of crumb rubber would have been consumed equivalent to 3,282,508 EPUs. It is projected bitumen market in Western Australia in 2026 is expected to be 139,337 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 20,901 tonnes of crumb rubber would be consumed equivalent to 3,483,424 EPUs. Refer to Figure 17 for projections for the years 2023 to 2026

Mandated Scenario – Western Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**131,300**	133,926	136,605	**139,337**
CRMB Usage (tonnes)	**131,300**	133,926	136,605	**139,337**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**19,695**	20,089	20,491	**20,901**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**3,282,508**	3,348,158	3,415,122	**3,483,424**

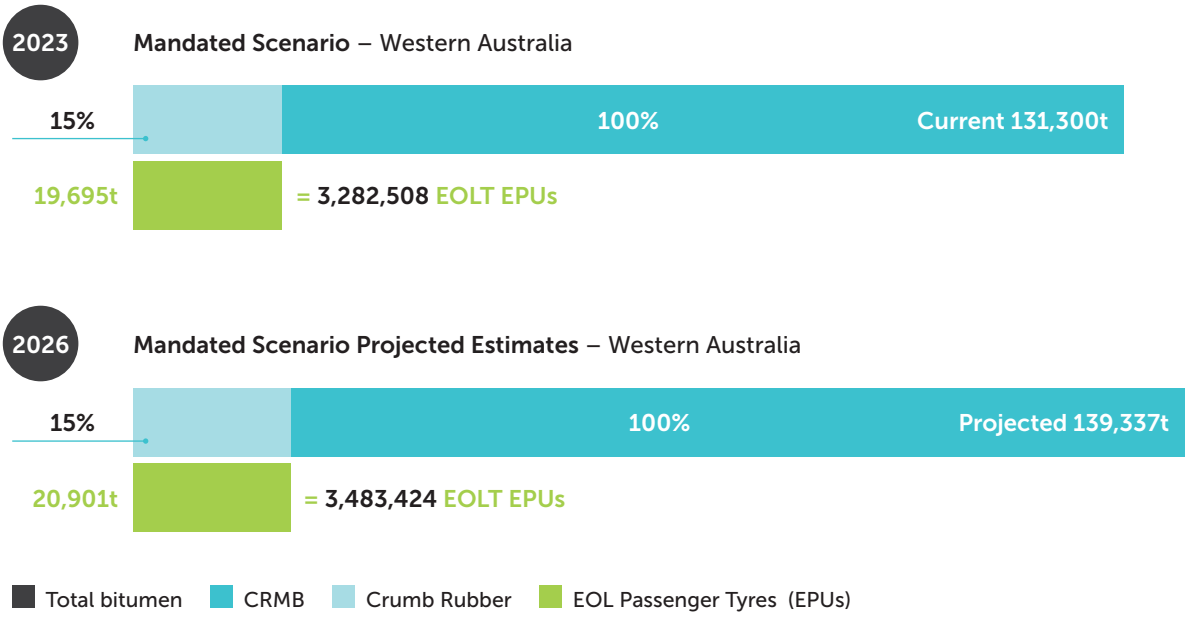


Figure 17: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – WA

Mandated Scenario – Key Result

- **Consumption of an additional ~3 million EOLT EPU on 2023 current scenario**

CRMB Volume Projections – South Australia 9

Current Scenario – South Australia 9.1

- **The overall estimated neat bitumen market in 2023 in South Australia was in the order of 71,618 tonnes.**

It is estimated that in 2023, 13.61% (9,750 tonnes) of the total bitumen used in South Australia was modified using crumb rubber, with the crumb rubber component being 1,463 tonnes, equivalent to 243,750 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in South Australia will be 76,002 tonnes of which 19.74% (15,000 tonnes) of it modified using crumb rubber with the crumb rubber component being 2,250 tonnes equivalent to 375,000 EPUs. Refer to Figure 18 for projections for the years 2023 to 2026.

Current Scenario – South Australia	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	71,618	73,051	74,512	76,002
CRMB Usage (tonnes)	9,750	13,000	14,000	15,000
CRMB Usage, % of overall bitumen used	13.61%	17.80%	18.79%	19.74%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	1,463	1,950	2,100	2,250
Crumb Rubber Component, % of overall bitumen used	2.04%	2.67%	2.82%	2.96%
EOLT @ 6 kgs CR per unit (EPUs)	243,750	325,000	350,000	375,000

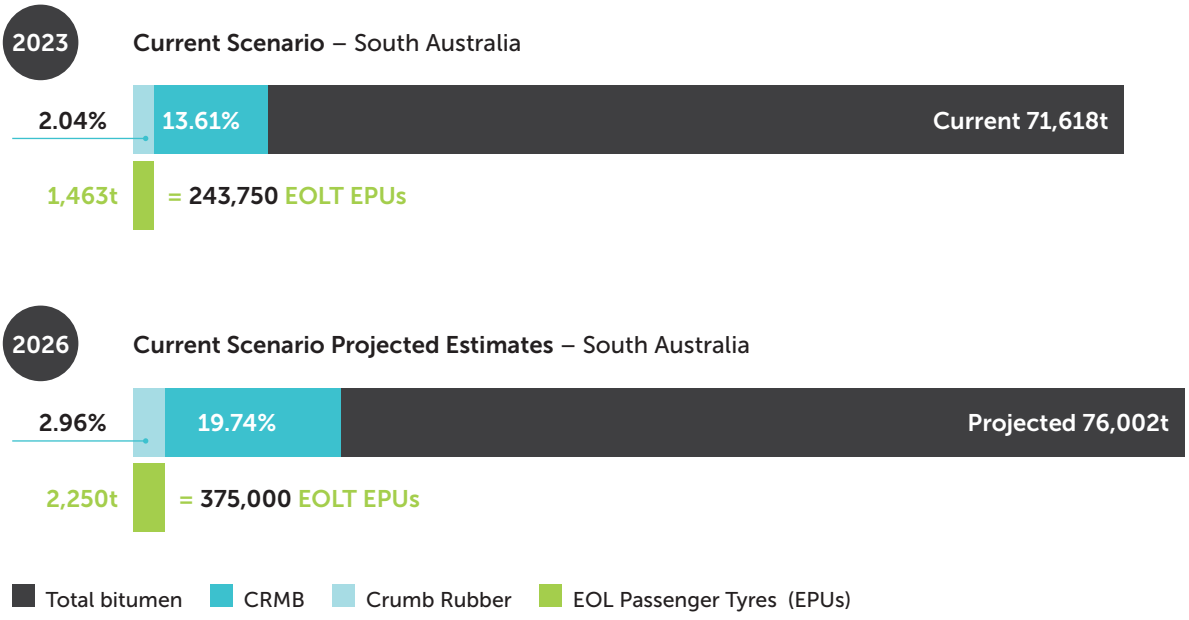


Figure 18: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – SA

Achievable Scenario - South Australia

9.2

Under the achievable scenario, it is estimated that in 2023, 48% (34,377 tonnes) of the total bitumen used in South Australia would have been modified using crumb rubber, with the crumb rubber component being 5,156 tonnes equivalent to 859,416 EPUs. It is projected that in 2026, for the neat bitumen market in South Australia of 76,002 tonnes and 48% (36,481 tonnes) of it modified using crumb rubber, the crumb rubber component would be 5,472 tonnes equivalent to 912,024 EPUs. Refer to Figure 19 for projections for the years 2023 to 2026.

Achievable Scenario – South Australia	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**71,618**	73,051	74,512	**76,002**
CRMB Usage (tonnes)	**34,377**	35,064	35,766	**36,481**
CRMB Usage, % of overall bitumen used	**48%**	48%	48%	**48%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**5,156**	5,260	5,365	**5,472**
Crumb Rubber Component, % of overall bitumen used	**7.2%**	7.2%	7.2%	**7.2%**
EOLT @ 6 kgs CR per unit (EPUs)	**859,416**	876,612	894,144	**912,024**

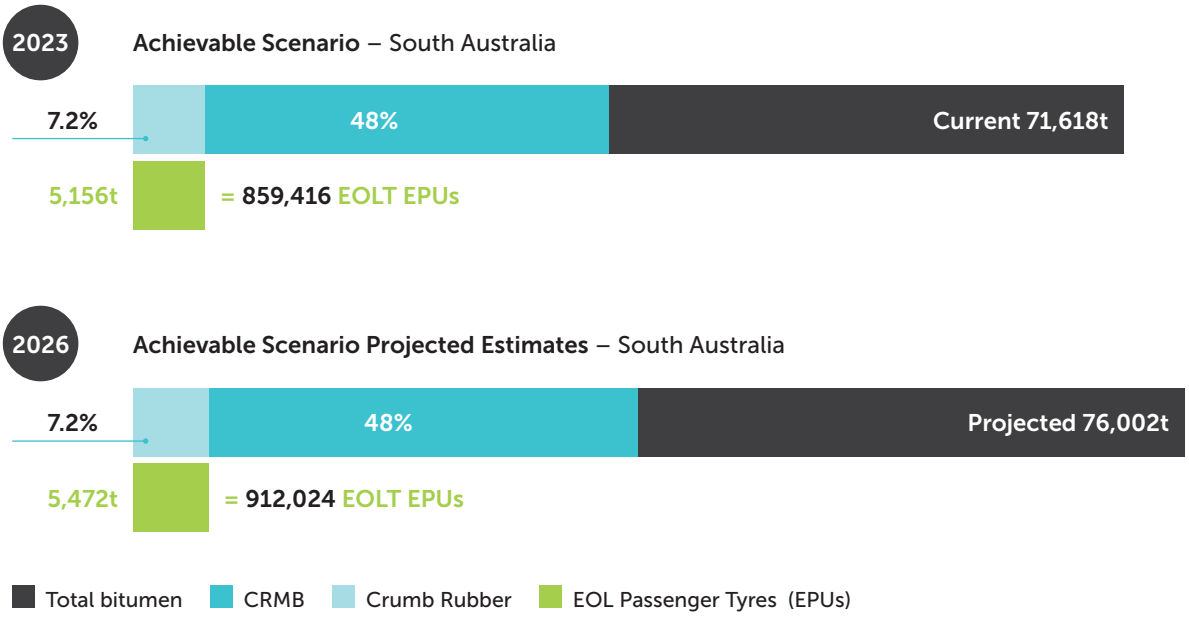


Figure 19: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – SA

Achievable Scenario – Key Result

- **Consumption of an additional 668,000 EOLT EPU on 2023 current scenario**

Mandated Scenario - South Australia

9.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (71,618 tonnes) consumed in road surfacing applications in 2023, it is estimated that 10,743 tonnes of crumb rubber would have been consumed equivalent to 1,790,450 EPUs. It is projected bitumen market in South Australia in 2026 is expected to be 76,002 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 11,400 tonnes of crumb rubber would be consumed equivalent to 1,900,050 EPUs. Refer to Figure 20 for projections for the years 2023 to 2026

Mandated Scenario – South Australia	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	71,618	73,051	74,512	76,002
CRMB Usage (tonnes)	71,618	73,051	74,512	76,002
CRMB Usage, % of overall bitumen used	100%	100%	100%	100%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	10,743	10,958	11,177	11,400
Crumb Rubber Component, % of overall bitumen used	15%	15%	15%	15%
EOLT @ 6 kgs CR per unit (EPUs)	1,790,450	1,826,275	1,862,800	1,900,050

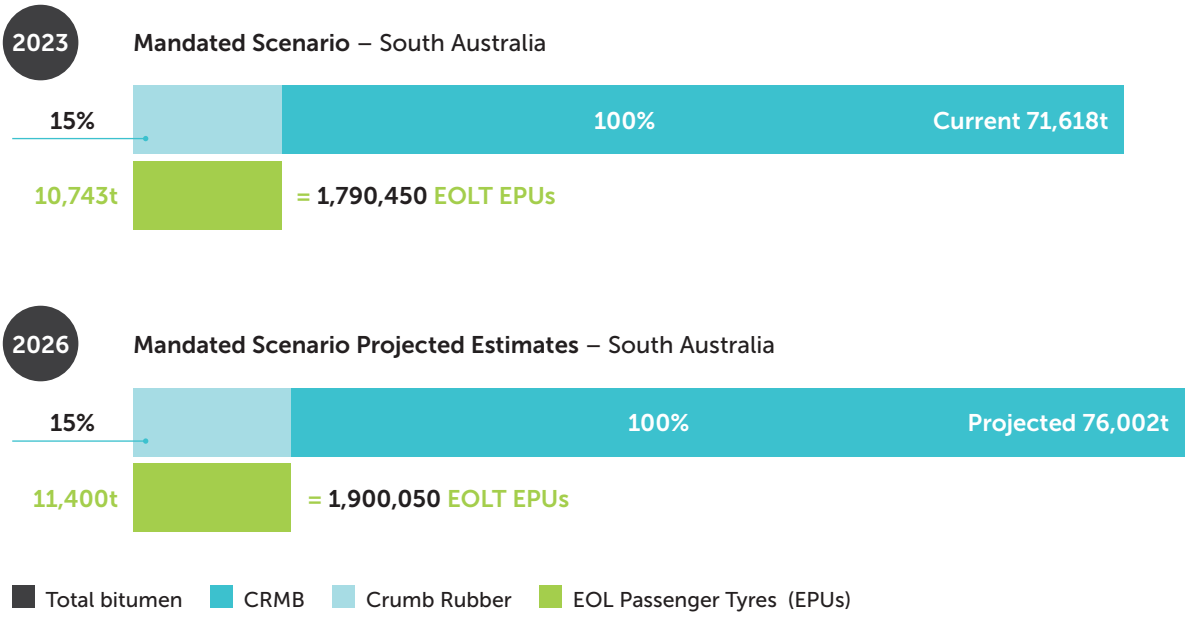


Figure 20: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – SA

Mandated Scenario – Key Result

- **Consumption of an additional ~1.6 million EOLT EPU on 2023 current scenario**

CRMB Volume Projections - Tasmania 10

Current Scenario – Tasmania 10.1

- **The overall estimated neat bitumen market in 2023 in Tasmania was in the order of 17,905 tonnes.**

It is estimated that in 2023, 6.43% (1,152tonnes) of the total bitumen used in Tasmania was modified using crumb rubber, with the crumb rubber component being 173 tonnes, equivalent to 28,800 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Tasmania will be 19,000 tonnes of which 15.79% (3,000 tonnes) of it modified using crumb rubber with the crumb rubber component being 450 tonnes equivalent to 75,000 EPUs. Refer to Figure 21 for projections for the years 2023 to 2026.

Current Scenario – Tasmania	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	17,905	18,263	18,628	19,000
CRMB Usage (tonnes)	1,152	1,600	2,300	3,000
CRMB Usage, % of overall bitumen used	6.43%	8.76%	12.35%	15.79%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	173	240	345	450
Crumb Rubber Component, % of overall bitumen used	0.97%	1.31%	1.85%	2.37%
EOLT @ 6 kgs CR per unit (EPUs)	28,800	40,000	57,500	75,000

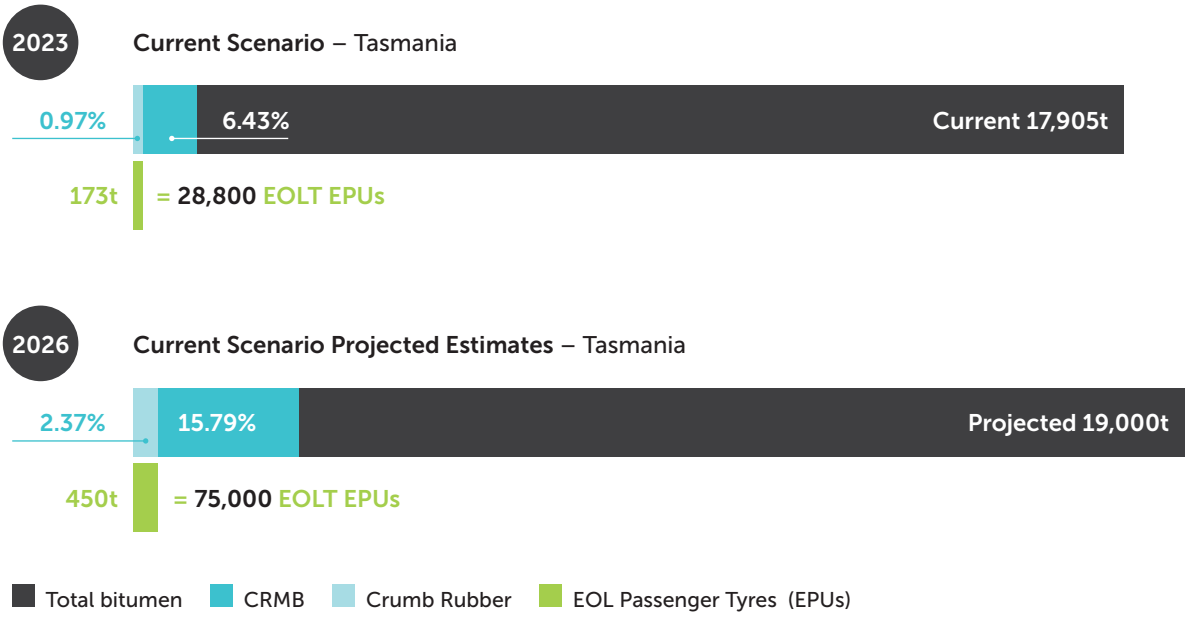


Figure 21: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – TAS

Achievable Scenario - Tasmania

10.2

Under the achievable scenario, it is estimated that in 2023, 48% (8,594 tonnes) of the total bitumen used in Tasmania would have been modified using crumb rubber, with the crumb rubber component being 1,289 tonnes equivalent to 214,860 EPUs. It is projected that in 2026, for the neat bitumen market in Tasmania of 19,000 tonnes and 48% (9,120 tonnes) of it modified using crumb rubber, the crumb rubber component would be 1,368 tonnes equivalent to 228,000 EPUs. Refer to Figure 22 for projections for the years 2023 to 2026.

Achievable Scenario – Tasmania	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	17,905	18,263	18,628	19,000
CRMB Usage (tonnes)	8,594	8,766	8,941	9,120
CRMB Usage, % of overall bitumen used	48%	48%	48%	48%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	1,289	1,315	1,341	1,368
Crumb Rubber Component, % of overall bitumen used	7.2%	7.2%	7.2%	7.2%
EOLT @ 6 kgs CR per unit (EPUs)	214,860	219,156	223,536	228,000

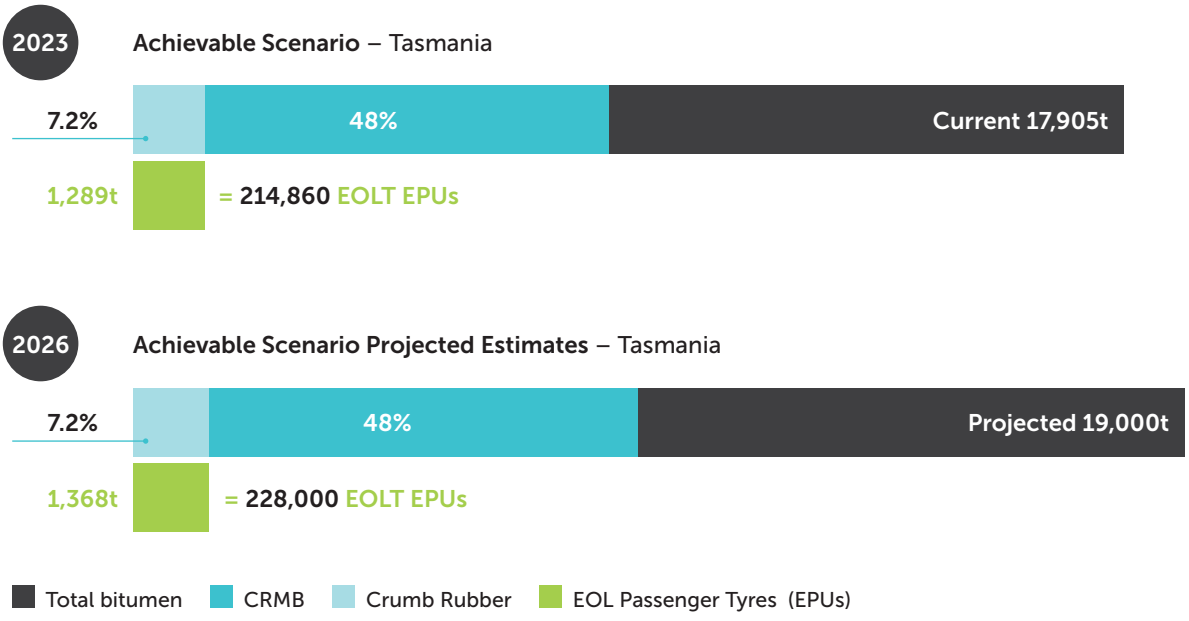


Figure 22: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – TAS

Achievable Scenario – Key Result

- **Consumption of an additional 199,200 EOLT EPU on 2023 current scenario**

Mandated Scenario - Tasmania

10.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (17,905 tonnes) consumed in road surfacing applications in 2023, it is estimated that 2,686 tonnes of crumb rubber would have been consumed equivalent to 447,625 EPUs. It is projected bitumen market in Tasmania in 2026 is expected to be 19,000 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 2,850 tonnes of crumb rubber would be consumed equivalent to 475,000 EPUs. Refer to Figure 23 for projections for the years 2023 to 2026.

Mandated Scenario – Tasmania	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**17,905**	18,263	18,628	**19,000**
CRMB Usage (tonnes)	**17,905**	18,263	18,628	**19,000**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**2,686**	2,739	2,794	**2,850**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**447,625**	456,575	465,700	**475,000**

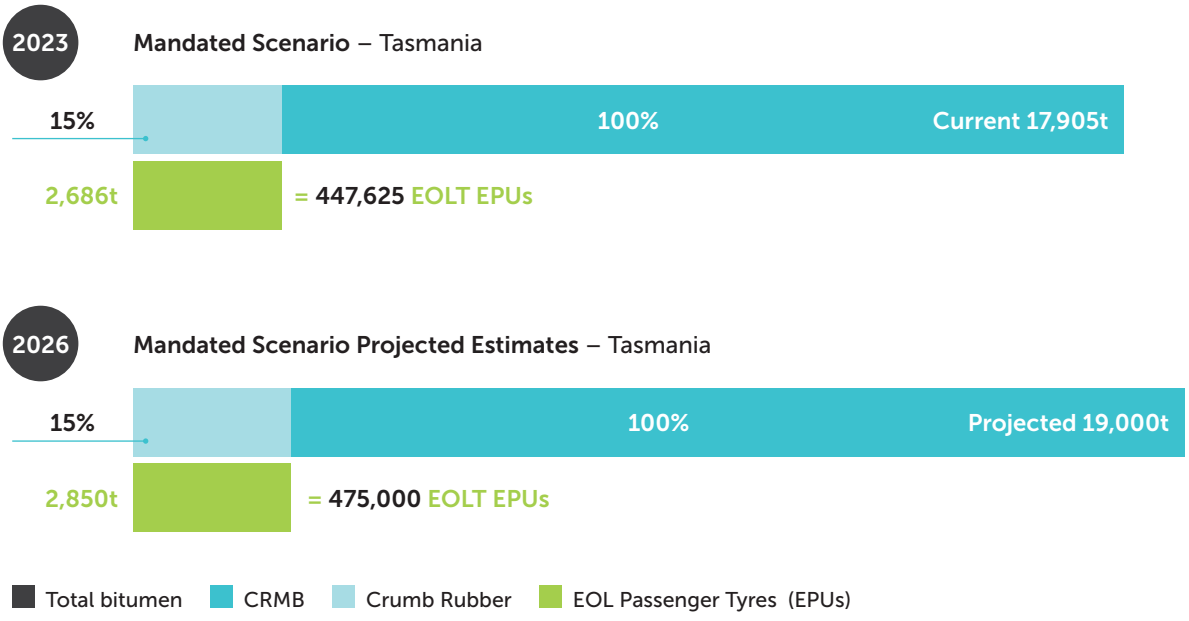


Figure 23: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – Tasmania

Mandated Scenario – Key Result

- **Consumption of an additional 446,200 EOLT EPU on 2023 current scenario**

CRMB Volume Projections – Northern Territory 11

Current Scenario – Northern Territory 11.1

- **The overall estimated neat bitumen market in 2023 in Northern Territory was in the order of 13,265 tonnes.**

It is estimated that in 2023, 1.88% (250 tonnes) of the total bitumen used in Northern Territory was modified using crumb rubber, with the crumb rubber component being 38 tonnes, equivalent to 6,250 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Northern Territory will be 14,077 tonnes of which 21.31% (3,000 tonnes) of it modified using crumb rubber with the crumb rubber component being 450 tonnes equivalent to 75,000 EPUs. Refer to Figure 24 for projections for the years 2023 to 2026.

Current Scenario – Northern Territory	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**13,265**	13,530	13,801	**14,077**
CRMB Usage (tonnes)	**250**	1,000	1,500	**3,000**
CRMB Usage, % of overall bitumen used	**1.88%**	7.39%	10.87%	**21.31%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**38**	150	225	**450**
Crumb Rubber Component, % of overall bitumen used	**0.28%**	1.11%	1.63%	**3.20%**
EOLT @ 6 kgs CR per unit (EPUs)	**6,250**	25,000	37,500	**75,000**

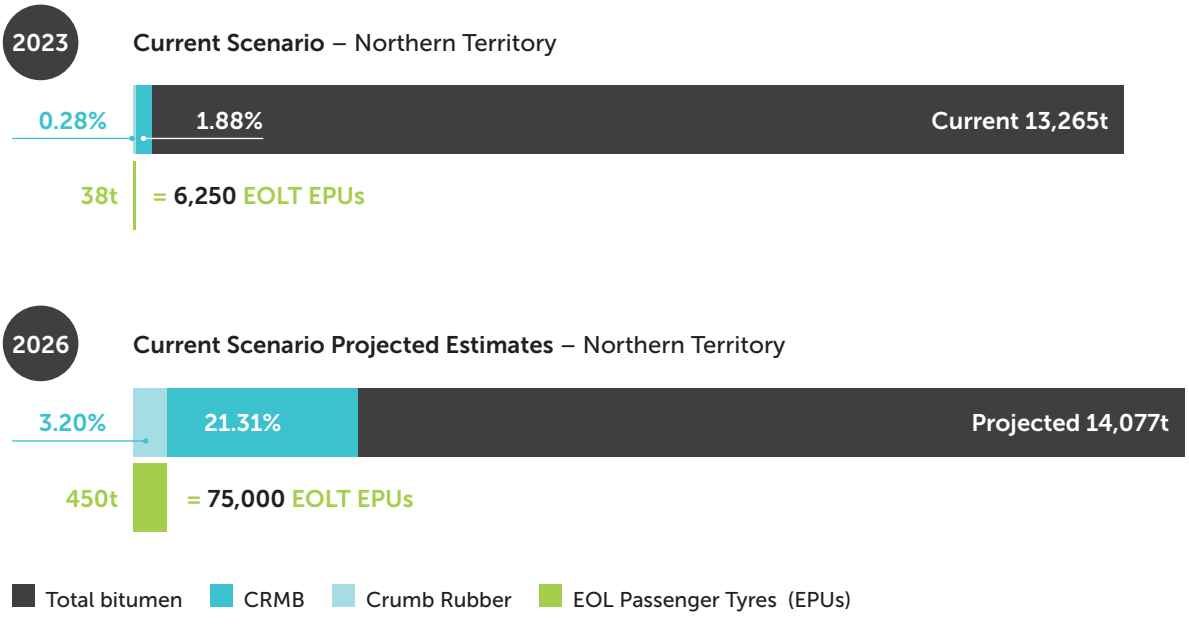


Figure 24: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – NT

Achievable Scenario - Northern Territory

11.2

Under the achievable scenario, it is estimated that in 2023, 48% (6,367 tonnes) of the total bitumen used in Northern Territory would have been modified using crumb rubber, with the crumb rubber component being 955 tonnes equivalent to 159,180 EPUs. It is projected that in 2026, for the neat bitumen market in Northern Territory of 14,077 tonnes and 48% (6,757 tonnes) of it modified using crumb rubber, the crumb rubber component would be 1,014 tonnes equivalent to 168,924 EPUs. Refer to Figure 25 for projections for the years 2023 to 2026.

Achievable Scenario – Northern Territory	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**13,265**	13,530	13,801	**14,077**
CRMB Usage (tonnes)	**6,367**	6,494	6,624	**6,757**
CRMB Usage, % of overall bitumen used	**48%**	48%	48%	**48%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**955**	974	994	**1,014**
Crumb Rubber Component, % of overall bitumen used	**7.2%**	7.2%	7.2%	**7.2%**
EOLT @ 6 kgs CR per unit (EPUs)	**159,180**	162,360	165,612	**168,924**

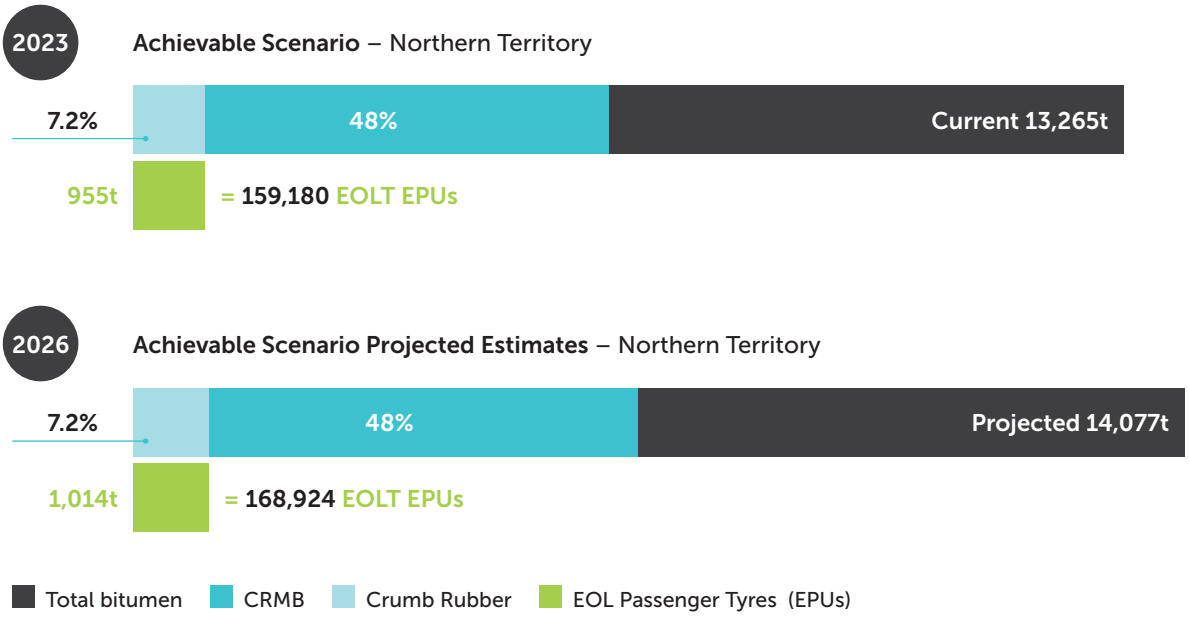


Figure 25: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – NT

Achievable Scenario – Key Result

- **Consumption of an additional 162,674 EOLT EPU on 2023 current scenario**

Mandated Scenario - Northern Territory

11.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (13,265 tonnes) consumed in road surfacing applications in 2023, it is estimated that 1,990 tonnes of crumb rubber would have been consumed equivalent to 331,625 EPUs. It is projected bitumen market in Northern Territory in 2026 is expected to be 14,077 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 2,112 tonnes of crumb rubber would be consumed equivalent to 351,925 EPUs. Refer to Figure 26 for projections for the years 2023 to 2026.

Mandated Scenario – Northern Territory	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**13,265**	13,530	13,801	**14,077**
CRMB Usage (tonnes)	**13,265**	13,530	13,801	**14,077**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**1,990**	2,030	2,070	**2,112**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**331,625**	338,250	345,025	**351,925**

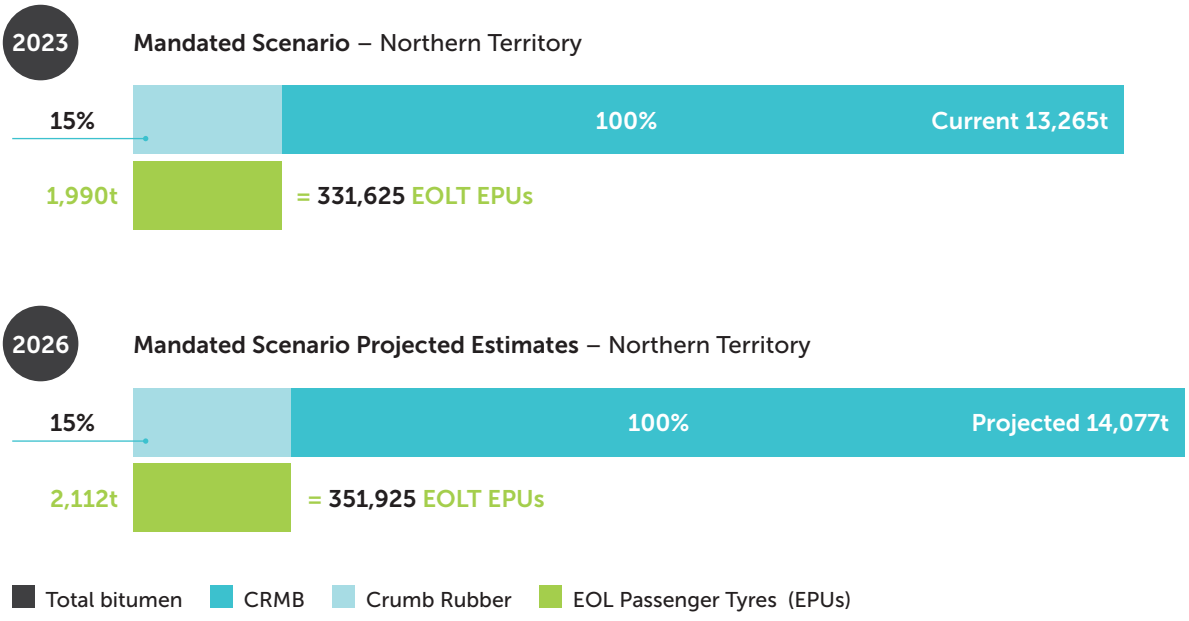


Figure 26: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – NT

Mandated Scenario – Key Result

- **Consumption of an additional 345,675 EOLT EPU on 2023 current scenario**

CRMB Volume Projections - ACT 12

Current Scenario – Australian Capital Territory 12.1

- **The overall estimated neat bitumen market in 2023 in Australian Capital Territory was in the order of 7,162 tonnes.**

It is estimated that in 2023, 17.29% (1238 tonnes) of the total bitumen used in Australian Capital Territory was modified using crumb rubber, with the crumb rubber component being 186 tonnes, equivalent to 30,950 EPUs. There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Australian Capital Territory will be 7,600 tonnes of which 19.54% (1,485 tonnes) of it modified using crumb rubber with the crumb rubber component being 223 tonnes equivalent to 37,125 EPUs. Refer to Figure 27 for projections for the years 2023 to 2026.

Current Scenario – ACT	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	7,162	7,305	7,451	7,600
CRMB Usage (tonnes)	1,238	1,290	1,388	1,485
CRMB Usage, % of overall bitumen used	17.29%	17.66%	18.63%	19.54%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	186	194	208	223
Crumb Rubber Component, % of overall bitumen used	2.59%	2.65%	2.79%	2.93%
EOLT @ 6 kgs CR per unit (EPUs)	30,950	32,250	34,700	37,125

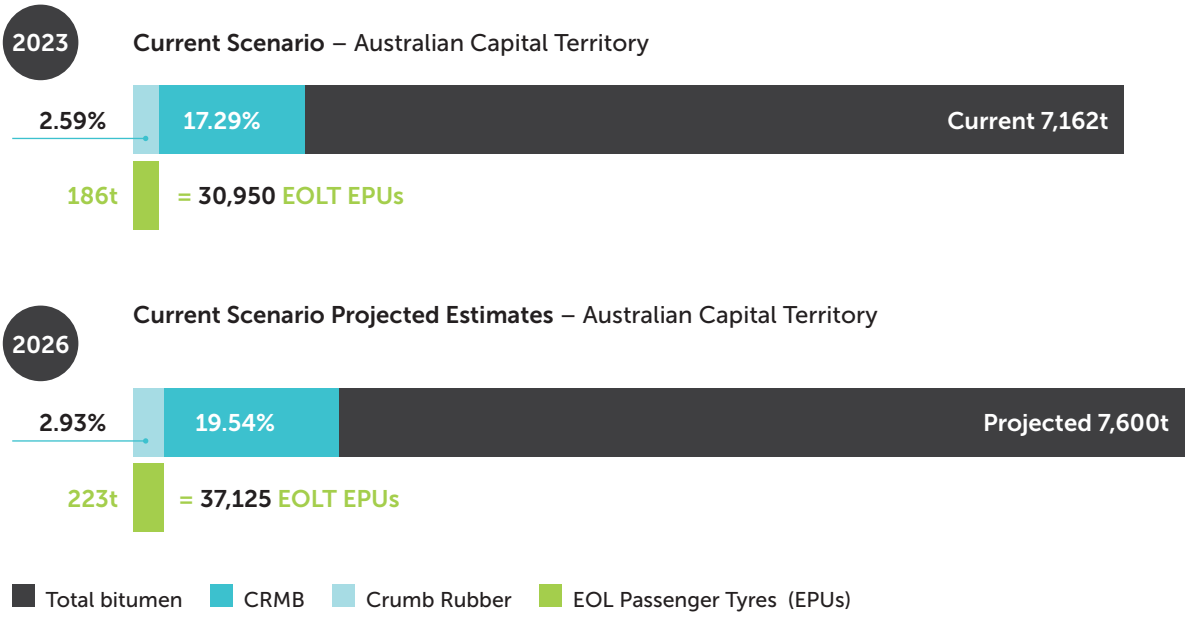


Figure 27: Bitumen, CRMB, CR and ELTs Projections under Current Scenario 2023 -2026 – ACT

Achievable Scenario - Australian Capital Territory

12.2

Under the achievable scenario, it is estimated that in 2023, 48% (3,438 tonnes) of the total bitumen used in Australian Capital Territory would have been modified using crumb rubber, with the crumb rubber component being 516 tonnes equivalent to 85,944 EPUs. It is projected that in 2026, for the neat bitumen market in Australian Capital Territory of 7,600 tonnes and 48% (3,648 tonnes) of it modified using crumb rubber, the crumb rubber component would be 547 tonnes equivalent to 91,200 EPUs. Refer to Figure 28 for projections for the years 2023 to 2026.

Achievable Scenario – ACT	2023	2024	2025	2026
Total Bitumen Usage (tonnes)	7,162	7,305	7,451	7,600
CRMB Usage (tonnes)	3,438	3,506	3,576	3,648
CRMB Usage, % of overall bitumen used	48%	48%	48%	48%
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	516	526	536	547
Crumb Rubber Component, % of overall bitumen used	7.2%	7.2%	7.2%	7.2%
EOLT @ 6 kgs CR per unit (EPUs)	85,944	87,660	89,412	91,200

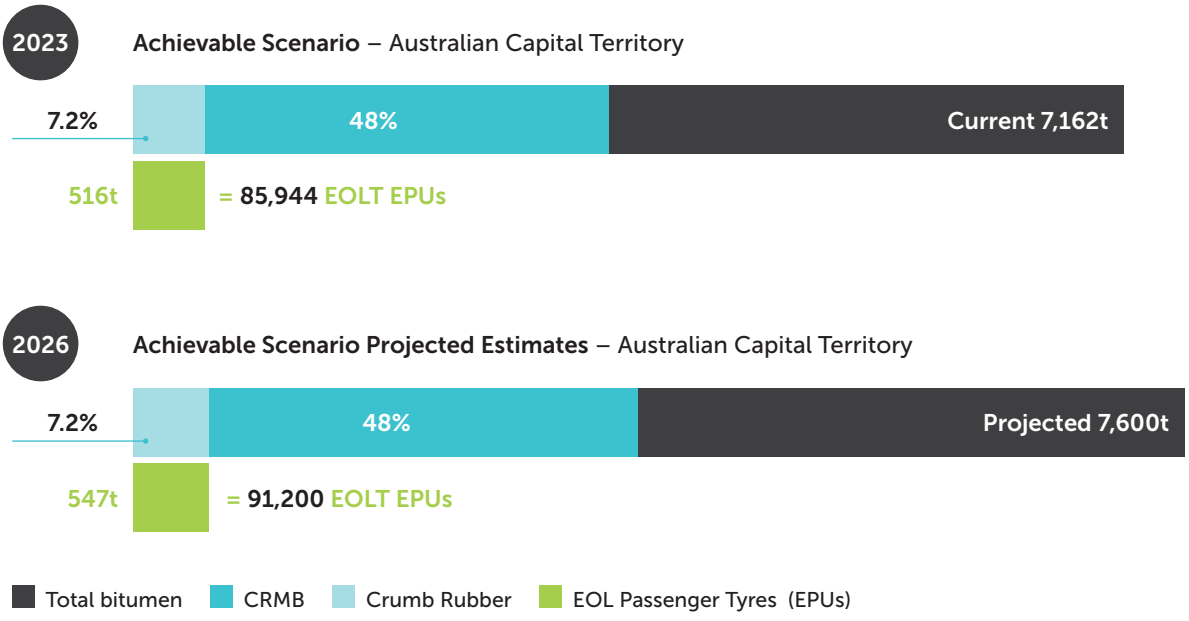


Figure 28: Bitumen, CRMB, CR and ELTs Projections under Achievable Scenario 2023 -2026 – ACT

Achievable Scenario – Key Result

- **Consumption of an additional 60,250 EOLT EPU on 2023 current scenario**

Mandated Scenario - Australian Capital Territory

12.3

Under a mandated scenario of using an average of 15% by weight of crumb rubber in all the bitumen (7,162 tonnes) consumed in road surfacing applications in 2023, it is estimated that 1,074 tonnes of crumb rubber would have been consumed equivalent to 179,050 EPUs. It is projected bitumen market in Australian Capital Territory in 2026 is expected to be 7,600 tonnes, at an average of 15% by weight of crumb rubber in all the bitumen consumed, it is estimated that 1,140 tonnes of crumb rubber would be consumed equivalent to 190,000 EPUs. Refer to Figure 29 for projections for the years 2023 to 2026.

Mandated Scenario – ACT	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**7,162**	7,305	7,451	**7,600**
CRMB Usage (tonnes)	**7,162**	7,305	7,451	**7,600**
CRMB Usage, % of overall bitumen used	**100%**	100%	100%	**100%**
Crumb Rubber Component equivalent @ 15% average loading in CRMB (tonnes)	**1,074**	1,096	1,118	**1,140**
Crumb Rubber Component, % of overall bitumen used	**15%**	15%	15%	**15%**
EOLT @ 6 kgs CR per unit (EPUs)	**179,050**	182,625	186,275	**190,000**

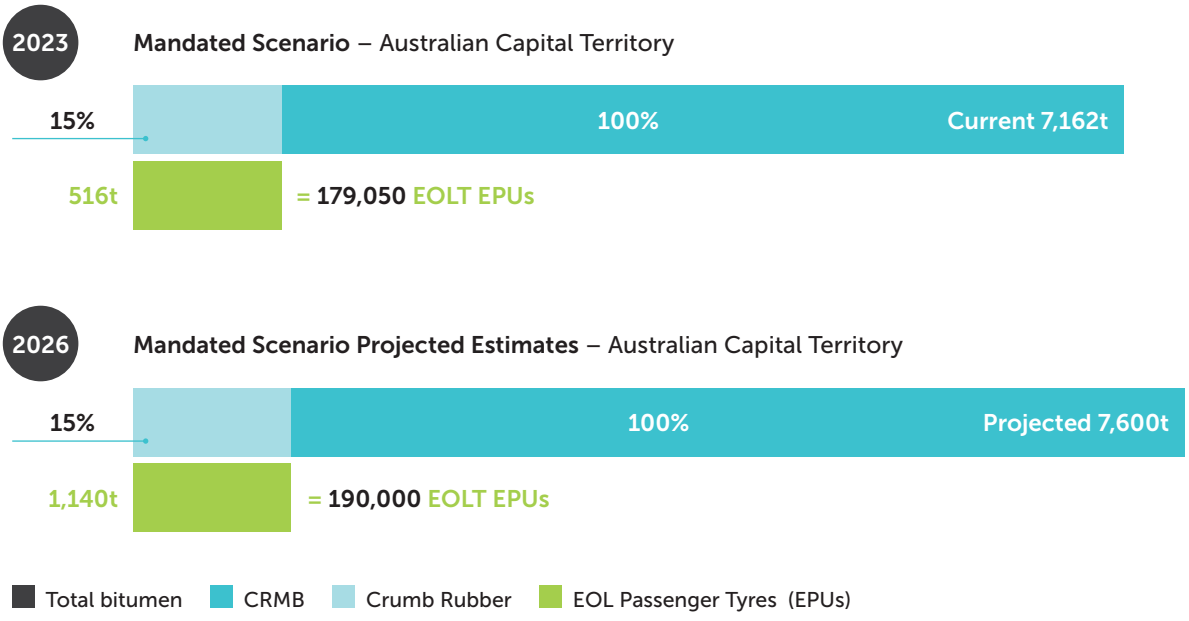


Figure 29: Bitumen, CRMB, CR and ELTs Projections under Mandated Scenario 2023 -2026 – ACT

Mandated Scenario – Key Result

- **Consumption of an additional ~159,050 EOLT EPU on 2023 current scenario**

About the Author

Azeem Remtulla is a Chemical Engineering graduate with Honours from Teesside University in North England. He has worked as a Process Engineer in London with a worldwide consultancy designing chemical plants. He moved to Australia and joined the newly created company for modifying bitumen SAMI, as a Research Engineer and served the company in a long and a distinguished career spanning 34 years in various technical, operational and commercial roles with responsibilities in research and product development, plant and process design, facilities construction, manufacturing operations and logistics. He was, until his retirement from SAMI, the Executive Director and General Manager of the SAMI Group of companies which included the specialties manufacturing arm SAMI Bitumen Technologies and series of SAMI Bitumen Import Companies located in various states across Australia.

Azeem is an accomplished scientist, pioneer of modified bitumen technologies in Australia and has made numerous presentations in Australia and internationally on modified, processed and cold bitumen technologies. He has also served on various committees over his lengthy career in the bitumen industry; these have included the membership of the National Technology and Leadership Committee of the Australian Asphalt Pavement Association (AAPA) and various Austroads committees on bitumen and bituminous binders. He is also a proud recipient of an award for the paper entitled "Recycling of Deteriorated Bituminous Pavements Using Emulsified Recycling Agents" presented at the first world congress on Emulsions held in Paris, France. He is also a recipient of several industry awards including the New South Wales (NSW) State Leadership Award for AAPA and the National Industry Leadership Award for AAPA for his sustained contribution to the flexible pavement industry and innovation in bituminous binders.

Azeem Remtulla is well known to the Australian and International fraternity of bitumen technocrats and road construction industry associations. He remains a strong proponent and a supporter of the bitumen and asphalt industry in Australia and Internationally with focus on playing a responsible role in the articulation, promotion and delivery of outcome based solutions using his deep understanding of unique bituminous binder technologies. His contribution to the bitumen industry, which he has served for over three decades, has been a significant one and continuous with his consulting company Bitumen Solutions Pty Ltd, formed 5 years ago focusing on promoting bituminous based solutions for pavements and industrial applications.

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